

THE THREE-TOED SLOTH

Bradypus cuculliger cuculliger Wagler

BY WILLIAM BEEBE

Contributions to the Life History and Anatomy of the
Mammals of Kartabo, Bartica District
British Guiana

(Figs. 1-23 incl.)

OUTLINE

INTRODUCTION
DETECTING AND COLLECTING SLOTHS
BRIEF DESCRIPTION
ABUNDANCE
HAUNTS
MIGRATIONS
HOME RANGE
SOCIABILITY
SPECIFIC INDIVIDUALITY
MOVEMENT
DEFENSE
SENSES
MENTALITY
HAIR AND SKIN
ENEMIES
FRIENDS
INTERCOMMUNICATION
FOOD AND FEEDING
ROOSTS
COURTSHIP
YOUNG
ANATOMY
EARLY LITERATURE
NOTES ON CHOLOEPUS—THE TWO-TOED SLOTH

INTRODUCTION

There are two species of sloths found at the Tropical Research Station of the New York Zoological Society, Kartabo, British Guiana. These are the Three-toed Sloth, *Bradypus cuculliger cuculliger* Wagler, and the Two-toed Sloth, *Choloepus didactylus* Linné.



Fig. 1. Head of adult male three-toed sloth. From a water-color drawing by Isabel Cooper.

reserving an account of the latter for a future paper, I present herewith the results of my observations on the Three-toed species. This Lentate was named in 1831, but very few observations have been made upon wild or recently captured specimens during the ninety-five years since that time. Upon this particular Guiana form the literature is almost nil, and I have summed up near the end of the paper all the published data I could discover worthy of quotation.

The paucity of notes on the three-toed forms is the more readily understandable when we realize that these animals, unlike the two-toed sloths, will not accept a change of diet in captivity, so while they feed freely and thrive within reach of their wild food plants, they will not survive transportation to northern Zoological Parks and Gardens. As regards the viability of *Bradypus* in confinement my own note of eight months at Kartabo seems to be a world's record as compared with one month in the London Zoo and three in our New York Zoological Park. On the other hand, the two-toed Hoffman's sloth, of which I shall have more to say later, adapts itself philosophically to captivity, and shows a record of nearly four years in New York and over eleven years in the London Zoo.

My notes on sloths are based both on careful studies and casual notes made at Kartabo, British Guiana in the research area of the tropical station, the observations being carried on over parts of several years, and including every month in the year. The individuals in confinement lived in semi-freedom on several good-sized trees on a terrestrial island, surrounded by a deep, three-foot wide, dry moat, which proved an impassable barrier. Old and young of both sexes have lived here for months, feeding, climbing, sleeping, courting, caring for their young, and in general living normal lives, except when I have removed them for swimming tests and other experiments. Some have escaped into the neighboring jungle, a few have died from special, interesting causes in no way connected with the conditions of their confinement.

DETECTING AND COLLECTING SLOTHS

Sloths have no right to be living on the earth, but they would be fitting inhabitants of Mars, whose year is over six hundred days long. There are only two similes in the world to which they may satisfactorily be compared, first, the Rath Brother acrobats, and second, a slowed-down motion picture.

The first time I saw a sloth it was a bunch of vegetable para-

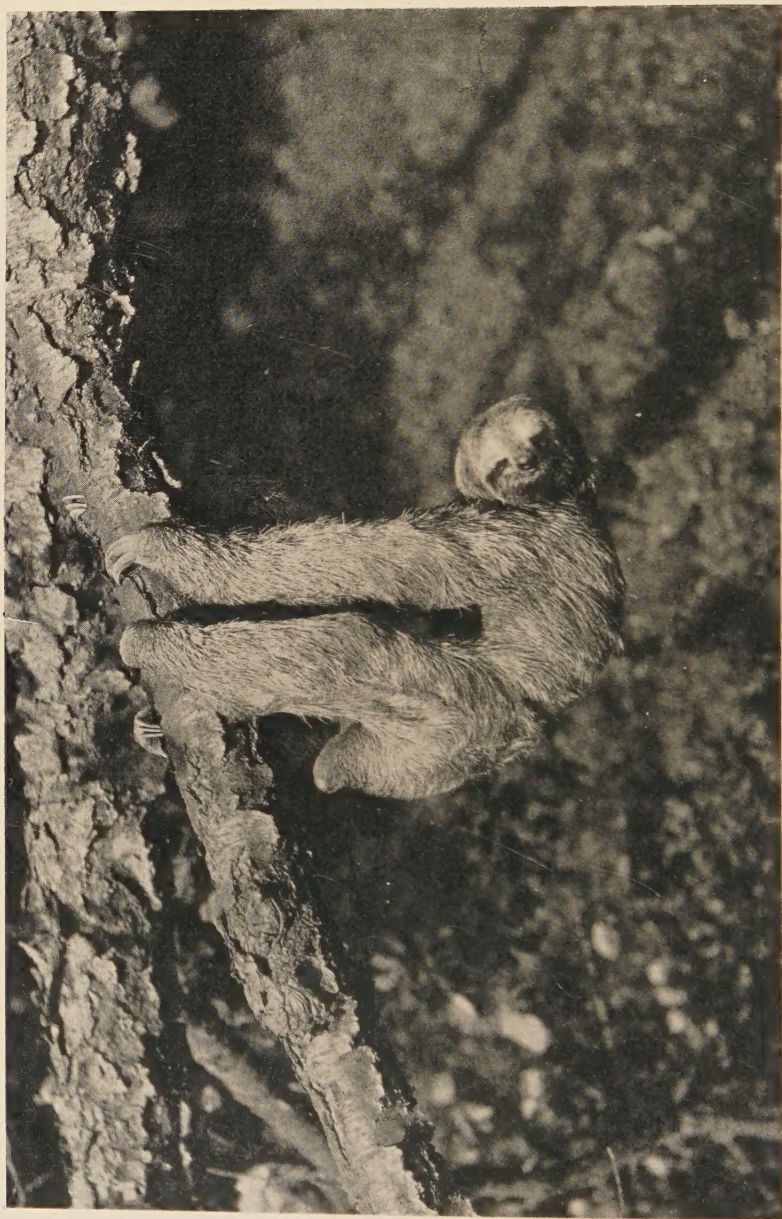


Fig. 2. Male three-toed sloth, showing great length of fore-legs and powerful tail which is useful in climbing. Photograph by Elwin R. Sanborn.

es, the second time it was a white ants' nest. At least that is what I supposed these were, but when I looked for them again, they were gone. The third time I saw a sloth, it was in a high tree. I fired at it and blew down a whole shower of roots, moss and stinging ants. From this time on I never called anything a sloth without shooting at it, or more frequently, watching until it moved.

To the sloth-seeker I can only say that no tracks or forms are visible, no hollow or nest offers a clew, and it is almost as hopeless to listen for its voice. I have found three ways of successfully procuring these animals, first, by sheer search, covering reasonably open jungle and river banks, scrutinizing every suspicious, dark, rounded mass in the branches; second, by going after every creature swimming in the rivers, on the very reasonable assumption that it may be a sloth, third, to notify the Indians and other natives to bring in all the sloths which they find among the branches of trees used in making their cassava fields. Once I tracked a sloth by its voice, and twice by sign, but these are rare feats of superlative woodsman'ship, or more honestly, pure luck or accidental flukes.

BRIEF DESCRIPTION

The senses of the Three-toed Sloth being of an exceedingly low order of development, there is little need for a face except as an assisting focus. The head is round, hardly differentiated from the remarkably long and mobile neck, while the face is as simple as the snout of a mammal could well be. The body is thick-set, short, and without great mobility of the vertebral column; the arms are slender and very long, a full third longer than the legs; the tail is short and stubby but a very useful organ.

The whole animal is covered with long, coarse, but strangely soft and silky hair, which serves as thatch in rain, and, with the dense under fur, as a real protection against the attack of many foes. The general color of this species is a grizzled drab, with irregular patches of dirty white on the dorsal surface. The males are highly colored for mammals, having bright orange ear patches and a rounded spot of the same color in the middle of the back. Very rarely an adult female sloth in the pink of condition will have dull orange ear patches, but never the brilliant back marking.

ABUNDANCE

Difficult as they are to discover, Three-toed Sloths are decidedly

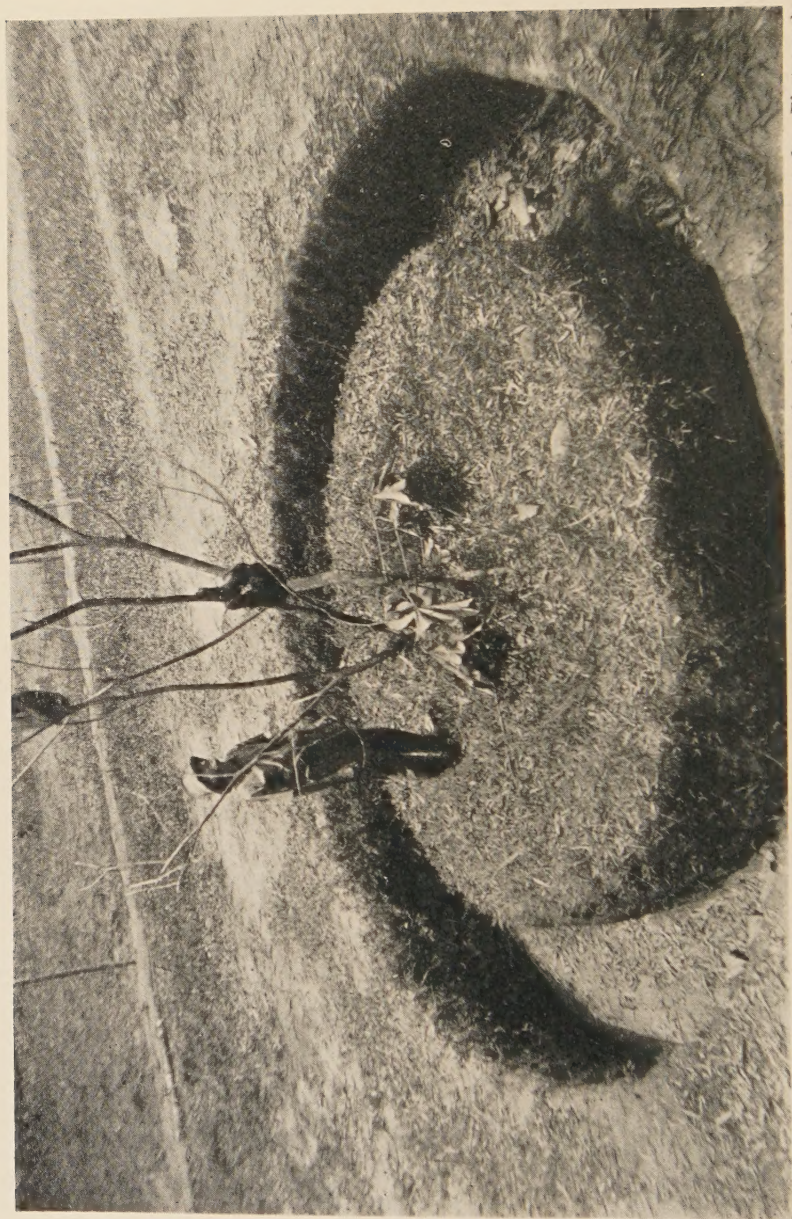


Fig. 3. Sloth tree at Kartabo, isolated by a dry moat, where many of the observations in this paper were made. Photograph by L. B. Moore.

common animals within the research area, and they are doubtless even more numerous than they appear to be. During two years, when the square mile about Kalacoon was being cleared of primitive jungle, fourteen sloths, four of which were carrying young, were found among the branches of the felled trees. This was before the opening of the Research Station. At Kartabo and the immediate vicinity I have notes on twenty-eight Three-toed Sloths, four of which had young, and two others large embryos.

If we take the agouti as the most abundant mammal of Kartabo, and the spider monkey as a type of the rarest, Three-toed Sloths must be classed as common. By the same criterion the Two-toed sloth would be decidedly rare. I believe that this would hold good for most of the interior of Guiana, while I have found a closely related form of the three-toed type to be actually abundant along the lower Orinoco. As to past history it is interesting to record, of this very region, that in the year 1876, Dr. W. T. Hornaday shot eight sloths from a dug-out along the west shore of the Essequibo, from Croete Creek to the mouth of the Mazaruni. Within a square quarter-mile of research area I estimate there are at least twenty resident Three-toed Sloths. I have seen three of these, and have captured several others, not counting those which have swum ashore.

HAUNTS

Sloths are lovers of river banks, and I can recall only one individual which I have seen more than a mile inland. In spite of the preceding section, the attraction is probably not the water itself, but the more open character of the jungle, and probably the abundance of food plants.

One of the most remarkable phases of the sloth's history is the readiness with which it takes to water. We have photographed a sloth coming ashore; I have thrown sloths into the river far from shore and watched them make their way to land, and altogether we have captured twelve sloths swimming in mid-river or taken them from islands where they had recently stranded. Kyk-over-al, the historic Dutch island, four hundred yards from our laboratory, and over five times that distance from the opposite bank, has provided our sloths, although it has only a few small trees wholly unsuitable for sloth food.

In every case which I could verify, the direction has been south or west, and, like the migration of the *Catopsilia* butterflies, the

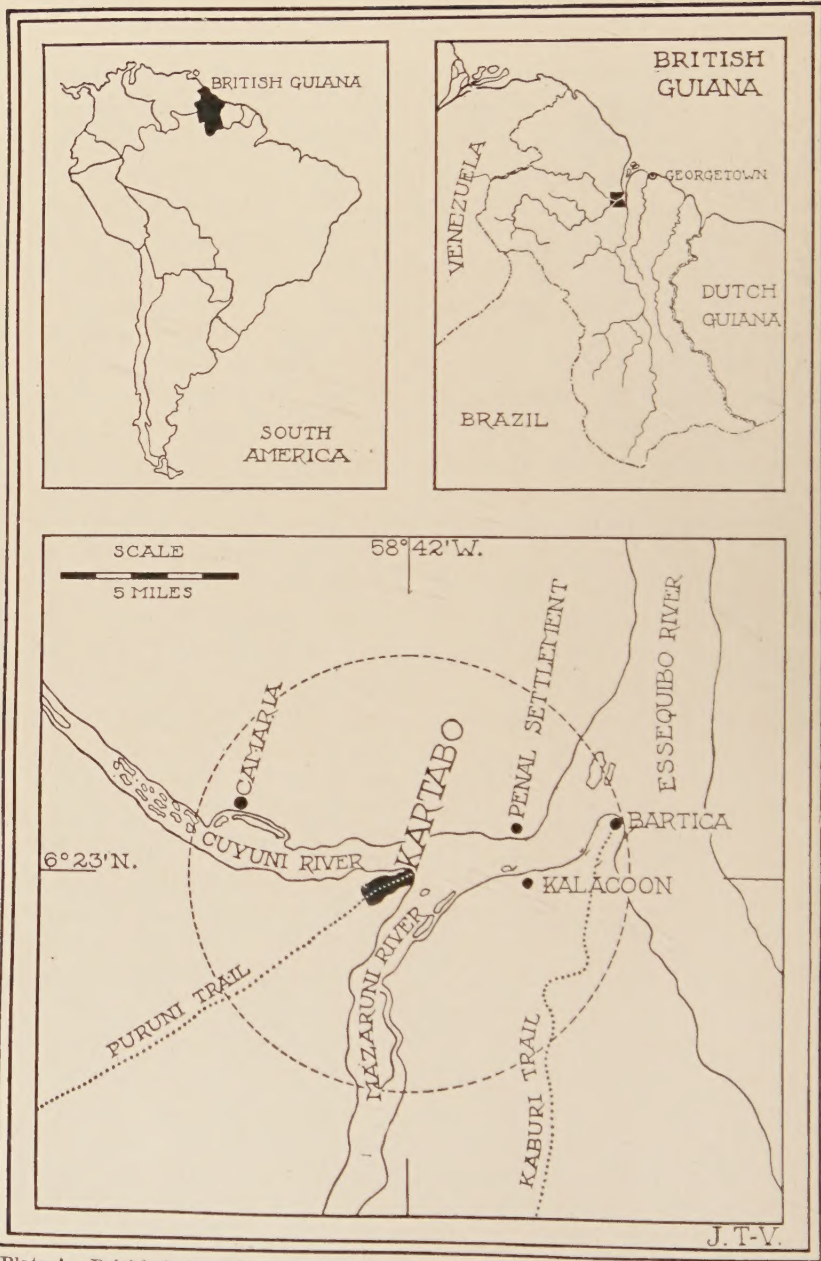


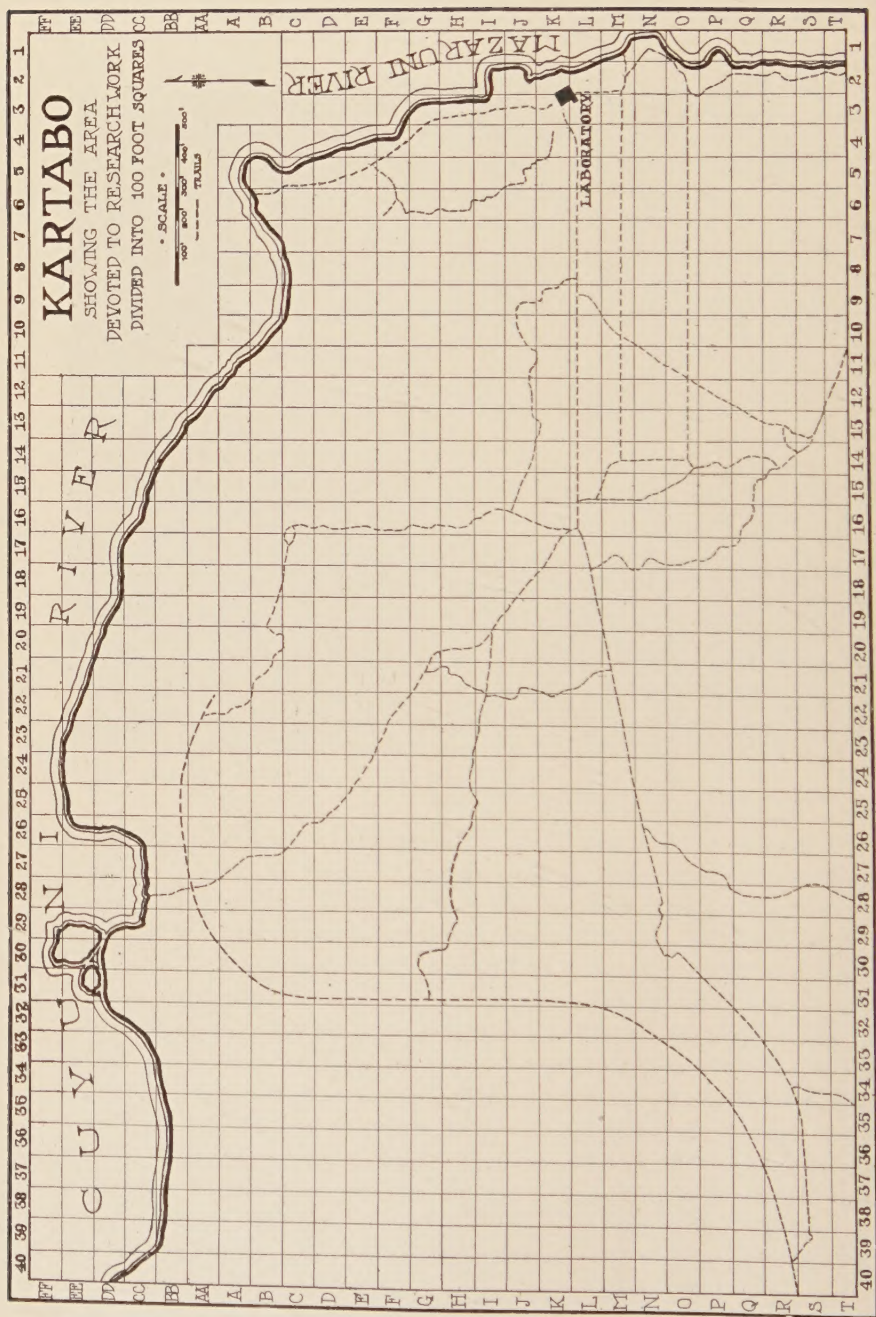
Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
Circle represents a radius of six miles.

Drawing by John Tee-Van



Fig. 4. Sloth carried by seizing the hair in the middle of the back, the only way to avoid the sharp claws. Photograph by John Tee-Van.

season wholly beyond my ken. The season of most abundant migration is the early part of the long wet season in May and June. There are few large voracious fish which could bite through the thick fur and skin, but crocodiles are far from absent and the tide and current are often much too strong for the sloths to swim obliquely across even at the most favorable times. Every sloth must be carried one or two miles down-stream in its trans-fluviatile progress. I am quite certain that none of these swimming sloths has fallen by accident into the water, for they know rotten boughs almost by instinct, and if they did fall in, they could if they wished climb out again at once. There is some urge, some powerful instinct, which brings these ultra-arboreally specialized animals down from the trees and out into vast expanses of water, with the opposite shore wholly unknown and quite invisible to them. The cause is certainly not due to lack of food or mates, or any disturbance from mankind. Like their distant relations, the great ant-eaters, they take frequently to water and that is all that we know about it.



MIGRATIONS

Except for these unaccountable departures and arrivals, sloths are as resident as the abundance of their food plants will permit. More ideal subjects for banding would be difficult to imagine, but whenever I have captured one I have usually wanted it for the Zoological Park, or for a specimen, and have only once marked a sloth. This was of interest, however. The sloth, a nearly full-grown male, had just swum ashore at Kalacoon, coming from upstream on the Mazaruni Settlement side, three-quarters of a mile across the Mazaruni. After keeping it five days, I shaved two patches of fur from the sides of the back, on the edge of the orange dorsal spot, and tied a metal tag to its leg. I liberated it in the jungle back of Kalacoon, and forty-eight days later it was brought to me from Ororaibo, a clearing with a few thatched huts on the west bank of the Mazaruni. To reach this place it must have gone west to the river bank from the mile inland where I liberated it, then turned south-west and taken to the water about two miles further up-river, then swum a mile west and down to the spot where it was seen to come ashore. The metal tag was gone but the shaved spots were unmistakable. The total distance was at the least four miles of jungle and one of river. Allowing a single day for the latter feat, we have an average of about one hundred and fifty yards of direct travel for each of the remaining forty-seven days. As there was a full moon during the interval it is probable that the animal made much of its progress at night. But two wide rivers and four miles of jungle, with an interval of only five days' rest in captivity in less than two months is almost enough to redeem it from being the type of inertness and laziness. Of the twelve sloths observed swimming the river, nine were males, and three immature females.

While this general seasonal shifting of certain individuals is apparent, the home range of these animals is more obscure. The old stories of a sloth spending its whole life on a single tree or never leaving it till every leaf is eaten is, I am afraid, pure fiction. For five days I have kept track of a female sloth which fed on three adjacent cecropia trees, and every night went back to the identical rotch of a dalli tree to sleep. She then vanished and a thorough search of the adjacent open jungle failed to reveal her whereabouts. It is probable that sloths are restless creatures and keep more or



Fig. 5. Three-toed sloth creeping painfully to the nearest tree. Photograph by William Beebe.



Fig. 6. Three-toed sloth climbing a cecropia tree. Photograph by William Beebe.

ss on the move, but I believe that usually their wanderings are rather limited, and the adult sloths often spend most of their lives, at least several years, in the same limited area of jungle. Besides several reasons which I shall elucidate later, I base this belief on the extreme regularity of their habits in captivity, and the routine tenacity apparent, whether the animal be confined in cage, vivarium or large enclosure.

SOCIABILITY

I have never seen even two sloths together. Once I saw two within a hundred yards of one another, but it might have been a hundred miles for all the knowledge they had of one another's presence. They are decidedly solitary animals and, as we shall see, the general law of relationship between sociability and voice holds good with them as with birds and other animals.

I have studied sloths for many years and have watched them for weeks in captivity. At this moment I have within a few feet, a three-quarters grown male, and two tame mother sloths, with a one-week, and a four-week old baby, respectively, yet psychologically, unless I brand them as being below reptiles and many amphibians, they are either a mystery or are beyond belief simple and dull; which is perhaps another way of saying that I am not able to put myself in their position and get their point of view of life. Still I am not so bad as Buffon, who chose sloths as the types of imperfection in nature, and wrote, "One more defect and they could not have existed." A sloth in Paris would doubtless fulfill the prophecy of the French scientist, but on the other hand, Buffon clinging upside-down to a branch of a tree in the jungle would expire even sooner.

Certain reactions of sloths to captivity, while they should be kept sharply distinct from the activities of animals in a state of freedom, yet possess a decided significance when exhibited consistently by all individuals. There is an interesting sequence of temperament through which all sloths pass when captured and placed in a cage. At first they show the resignation to fate characteristic of the free animal when approached on their native branch. They roll up, hide their heads, and wait for the blow to descend, or to pass. After a few days when there comes to their dull comprehension the fact that my presence does not mean physical harm, they begin to move about freely and to feed, and with this phase is correlated a taciturn resentiment of my approach, and instead of cringing, they make futile attacks with their fore claws, and then climb slowly away.

After two, or with some especially dull individuals, three weeks, the sloths become tame, and will come for food when it is brought, will allow themselves or their young to be stroked, exhibiting day and night, the eternally characteristic emotion of the race of Three-toed Sloths, that of passive tolerance.

SPECIFIC INDIVIDUALITY

Habits are formed very quickly, and when a satisfactory roost is chosen on one night, it is resorted to without hesitation the next and thereafter. Food location is also fixed in mind after a single feeding. In a small cage when a newly caught sloth has once made an escape, as between the wire and the ground, the occurrence is not forgotten. The animal will sprawl flat and continue its efforts at escape, even in imminent danger of crushing its young, for several hours each day, writhing about on the bottom of the cage and poking blindly against the wire with its head. If removed to a new cage for a few days, and then returned, all memory of the happening is gone.

Dully tolerant as sloths are of whatever life or fate may bring, they are extremely intolerant of one another. If several are placed on a large tree for observation, one will always make it uncomfortable for the others, but in a small cage it is as good as murder to put two sloths, especially if they be females, together. Males, or a male and a female, will usually live grudgingly together, giving one another occasional hooks with their claws, but two female sloths present the most unpleasant sight imaginable. After a brief sparing, one gives up and flees and never after attempts to defend herself. The other may for a time languidly feed, or sleep for hours, but it never forgets its companion, and sooner or later it climbs slowly to the hunched-up unfortunate, and deliberately begins to inflict as much damage as possible. Hook after hook is made, and the mysterious part is that the persecuted sloth permits herself to be unrolled and systematically clawed, a single swing sometimes tearing part of the tender skin of the nose. Wailing at each attack, the hopeless creature lets go and lies flat on her back, with all her vulnerable parts exposed, apparently awaiting death at the hands of her fellow sloth. The attacker tries now and then to bite, usually vainly. Only once I saw one get hold of a hand instead of a mouthful of hair, and from the way it was wrenched and from the ensuing wail, the flat teeth must be able to cause considerable pain. I have never

allowed such an attack to continue, it is too horrible, and I know of no other mammalian conflict which is so abhorrent. The idiotic, motionless faces of the sloths, one emitting a series of plaintive wails through the nostrils and without attempting either to ward off blows or to retaliate; the other slowly and systematically setting to work to destroy her sister;—this is decidedly the least attractive side of sloth life.

MOVEMENT

Every muscular movement, sensory reaction and mental process is slowed down in these animals; their lives are spent wholly in low gear. They are the personification of slow deliberation, and only from an anthropomorphic bias can they be termed lazy or slothful. A turtle shows sometimes the slow, deliberate movements of these mammals, or a heron stalking a fish; a chameleon also in its syndactyle climbing; but turtles or herons can hurry if they choose, while to a sloth, haste is inconceivable. When, however, a sloth lifts itself from branch to branch, drawing its whole weight upward with three fingers and no effort, or, stretching far across an open space, brings body and legs after without shock or swinging impetus, one is forced to admiration, as in the supremely graceful, effortless feats of superlative acrobats, or the analysis of movement of some animal in swift action in a slowed-down motion picture.

A jerk or sudden movement is unknown to a sloth between birth and death. The nearest approach is what pugilists would call a short-arm hook, with which the sloths endeavor to defend themselves, and the exertion of this is so great that if they miss the object aimed at, the impetus often completely upsets them.

In connection with exertion it is interesting to note that a sloth breathes about once a second, but very irregularly. An average of several trials gives twenty breaths to sixteen seconds. After swimming nearly one hundred feet, and being angry into the bargain, a sloth breathed twenty-five times in twenty-five seconds, most of the exhalations carrying a hissing grunt, an involuntary, non-vocal protest against my holding him. The temperature of an adult female sloth was $95\frac{1}{2}^{\circ}$.

The human failing of exaggeration in the estimate of speed is as evident in the case of slowness as of rapidity. A race horse may seem fairly to fly over the ground, until pulled down to the actual record by a stop watch, and to all the earlier observers, the fact of

the unusual slowness of sloths led to the most ridiculous estimates of their speed.

A mother sloth on the ground, speeded up by the calls of her infant, made fourteen feet in one minute, and while I have known this to be considerably surpassed, yet it is a fair average of twenty tests made with half as many animals. This corresponds to a mile in six and a half hours. In the trees this speed may be increased to two feet a second. The most unexpected record of a sloth's activity is that of swimming. An average is the feat of a male, not particularly vigorous, which swam sixty-five feet to the nearest bush on shore in two and a half minutes. This is one foot in two and a third seconds, which is to say that, ignoring all contrary currents and tides, a sloth, keeping up this rate of progress, could cross a mile stretch of river in three hours and twenty minutes.

A sloth swims remarkably high out of water, three-fourths of the head and much of the back being exposed. Even when thoroughly soaked, considerable of the back is above the surface. The strokes are made at the rate of one to three-fourths of a second and almost all the propulsion is with the front legs. These swing around alternately on each side, nearly to the tail, while the hind legs and the posterior half of the body waggle feebly from side to side, to meet first one, then the other backward-coming front leg.

The mobility of the neck and forearms of sloths is almost that of universal joints. When we remember the necessary rigidity of the limbs of running animals, we realize that a deliberate and an arboreal life has its characteristic compensations.

The head and neck can be, and in sleep always are, brought forward and around until they are flat on the breast. When needful, the neck can be stretched back in the opposite direction, until it is below and at right angles to the longitudinal body axis. This indicates a superior-inferior swing through an arc of 270° . From a normal position parallel with the vertebral column, the head and neck can be revolved laterally to an equally surprising extent, three-fourths of a circle. For example, if the sloth, while in an upright position, is looking north, it can slowly turn its head to the right, through east and south, to west and on even somewhat farther, to west by north.

The elbows can be brought together in front and behind the body, over the head and down across the abdomen. With the lower leg pointing tailward, the knees cannot be brought closer together in

ont, than parallel, nor when stretched laterally can they be brought further back than a straight transverse line. Posterior to this line they will go only a short distance. Thus there is a very great degree of difference between the mobility of the fore and hind limbs.

When the lower legs are brought inward across the abdomen, however, the upper limbs approach somewhat nearer, 65 mm. instead of 85 as in the first instance.

When stretched straight out laterally, the hind limbs can be rotated tailward until they touch, thence allowing an anterior revolution of 180° until they lie alongside the body. When thus stretched forward, the tip of the foot falls short of the armpit, reaching the mammary glands.

The forearm can be revolved upon the humerus through a half circle; if the arm is stretched out laterally, with the palm upward, it can be turned so that it faces directly forward and as completely back. The lower legs and the soles can turn only about 45° in either direction.

With the forearm in the same position, the hand can be bent back at a right angle and forward three-quarters or 70° of the way to the forearm. It can be rotated almost at a right angle (80°) posteriorly, but only 40° forward. The claws can be stretched straight out, and flexed through 180° , until they touch the palm. The hands and feet, together with the claws, are practically immobile except in an externo-internal direction.

The body can be rolled up until the back is in a perfect ball, and the nose touches the tail-tip, but a backward bend is an impossibility. There is almost always a curve in the lower back, about sufficient to compensate for the disparity in length of the hind as compared with the front limbs.

The tail is very short, thick, rounded, and tapers rapidly with an abruptly outward curved tip. It is very mobile, and will pass dorso-ventrally through an arc of 180° and laterally through 134° . While this movement is chiefly basal, yet even the tip is movable. This lateral portion is covered so densely, and with such short, thick hairs that it appears bare.

It is a mistaken idea that sloths spend all of their lives upside-down. When travelling and often when feeding, they do hang suspended, but quite as often they are climbing or clinging on vertical stems, or actually sitting down, as when asleep. On the other hand it is physiologically impossible for them to stand upright on



Fig. 7. Mother and baby three-toed sloth, showing method of carrying the young when the parent is in motion. Photograph by William Beebe.



Fig. 8. Mother and baby three-toed sloth. The parent is beginning to wrap her body and limbs about the infant to protect it from danger. Photograph by William Beebe.

fours either on the ground or at least for more than a moment on the branches. I have thus modified this last statement because of the achievement of a newly caught male sloth. This animal, when liberated on my sloth tree, climbed at once to the top, and then, eager to reach the bamboos above him, which his poor eyesight failed to reveal as still twenty feet beyond the reach of his claws, he actually stood *upright* on the topmost branch. He gripped it tightly with all four feet, and for a few seconds, held himself quite at full leg length, the strangest sight I have ever seen in my studies in slothdom.

To get a better view I walked beneath him, and when he saw me, he relaxed one-foot-hold and slid at once down to normal sloth attitude. He then let go with first one, then the other forearm, and even one hind foot, and stretched far down toward me, seeing in me the hope of another tree. Everything that comes near a sloth is Birnam Wood to him.

When hanging, the support of the species under consideration is usually wholly the twelve claws: when climbing, the feet are brought into play, the elongated tarsals and metatarsals of the front foot, and the corresponding series, aided by an extremely elongated calcaneum in the hind foot, forming with the claws a peculiar type of didactyle grip which is perfect in its adaptation to its requirements. The claws can be straightened out, as when reaching for a branch, or hooking over the ground. The reported danger of being caught in the grip of these is imaginary, for while they can give a severe pinch, they cannot cut through the skin unless an attempt is made to wring the hand away. The curving slice which they give occasionally is a different matter and can inflict a deep cut. Their method is usually to strike forward in the direction of the enemy and then bend backward, curving the arm around with claws half flexed.

DEFENSE

When fully enraged, having mentally attained the emotional level of annoyance of other wild animals, male sloths will, at this stage, slowly reach forward with the head, open the mouth and attempt a languid bite. I have known one to bite its own wrist, mistaking it for my hand. I have not experimented with the efficiency of this mode of assault, but probably if given time and perfect convenience of grip they could chew enough to do considerable damage. Each defense is pitiful against the swoop and talons of a harpy, or the claws of a cat, or the crushing coils of an anaconda.

Every Three-toed Sloth has its individual expression, but this never changes under stress of emotion, hunger, anger, sleep, even when nearly drowned after a mile of swimming, always there is the same, humanly-speaking, smug, wide-eyed, vacant outlook upon life. In what the sloth conceives the last extremity, there comes a shrill, heart-rending whistle through the nostrils, accompanied by not the slightest quiver of muscle or shifting of feature.

SENSES

The senses of sloths are of great interest from their simplicity. In the order of progressive efficiency I should name them taste, touch, sight, hearing and smell, and using the arbitrary range of II to X, to express respectively unusual dullness and extreme acuteness, I offer the following:

	II	V	X
TASTE	Sloth	Dog	Man
TOUCH	Sloth	Man	Electric Eel
SIGHT	Sloth	Man	Eagle
HEARING	Sloth	Man	Deer
SMELL	Man	Sloth III	Dog

Interest in the strange life and ways of adult sloths and the disarming charm of infant sloths are very liable to obscure the real status of their mentality, and after experiences with animals and birds which dash themselves against their cages, or mope and perish from no reason which we can discover, we are inclined to be over-enthusiastic as to the philosophic acceptance of captivity by sloths. But when we divorce from the question of their psychology all sentiment and false tameness, we are face to face with the fact that they have achieved a niche for themselves where they live, thrive and increase with the very least possible development and specialization of sensory perceptions and mental processes. Let me give a few concrete examples.

In the foregoing table I have neglected the level of I, because that would represent the very lowest, and feeble as are the senses of sloths, they are least clearly recognizable. As regards taste, only once or twice have I ever seen a sloth sample a leaf and then reject it. It invariably uses the sense of smell, and either turns away or begins feeding at once. However insipid may be the flavor of cecropia leaves, they never pall, and are detected and munched in preference to any other foliage of the jungle. Tests of touch have been made

When the sloth was asleep and it was quite on a par with taste; two or three nudges will awaken the animal and make it look sleepily in every direction but the right one. When wide awake and fencing vigorously, if a sloth is touched on the back, it will look up and down before it occurs to it to twist its wonderfully mobile neck and look behind. There is no delicacy in feeding; it simply munches until it reaches the base of the leaf and then starts on another, without any sense of feeling or touch.

The eyes of sloths are small, expressionless, very convex and prominent. In the adult the iris is of a deep tawny while in the young it is considerably lighter, more nearly a yellow ochre. They are very conspicuous because surrounded by a circle of black hair. In the young and immature animals, several rows of these are slightly lengthened and stiffened, forming very imperfect eye-lashes. The eyes are placed above the level of the nares, and close to and exactly above the posterior corner of the mouth. They are directed forward with a divergent angle of about 25° , which in the young is reduced to 23° .

The pupil is exceedingly small, in daytime being reduced to a mere pin-point. Even at night, when a light is suddenly flashed on the just-awakened animal, it is only about $\frac{1}{4}$ of the eye diameter. At death it relaxes to about half the diameter of the visible pupil and changes to a wide vertical ellipse. The eye-ball is quite prominent, about 10 mm. in diameter. The eyes have very little power of revolution, and even when close to an object still keep their outward divergent angle, with almost no adjustment. The lids are ill-fitting, and in the adult practically bare of eye-lashes. When fully open, the eyes are almost round, and the scantiness of eyebrows and lashes gives them a peculiar staring look. They are usually half quite closed, however, and sometimes when feeding, they will remain closed for five minutes at a time. If a feint be made as if to strike the animal, instead of dodging, it will simply shut its eyes, cover its head and wait resignedly. Sloths wink frequently and very slowly, and as often as not, with one eye at a time. This adds to their general comical expression, the solemn, staring creature deliberately winking with right or left eye, the expression being as quaint as usual. One of the most inexplicable habits, especially when wet and drying off, is to nearly close the eyes, and half asleep, bask directly at the sun for ten minutes to half an hour.

I have made numerous experiments with regard to the eyesight

of sloths, and can allow them no more than II, the imperfection of which may be gauged when we compare my comparative values of man V, and eagle X. Sloths are very short-sighted, so much so that it is impossible to think that this sense functions in any but the most unimportant way. It is inconceivable that sight is of the slightest use in finding food-trees, mates, or avoiding danger, at any but the very shortest distances.

It is interesting, as I shall detail later on, that there is a very appreciable ontogenetic change in vision. The very young sloths have better eye-sight, and shift their heads more in keeping with this improvement. Their eyes focus better, and unquestionably rotate inward, more toward an approach to parallel vision when looking closely at anything. The eyes are, as I have said, much lighter in color than those of the adults, and the pupil is comparatively larger.

Hearing in sloths is a worthy corollary of the voice. It exists, but that is about all that can be said of it. The ears are well back on the sides of the head, and measuring along the line of the mouth, they are just above it on a level with the eyes. The cephalo-nuchal mop or thatch of hair ends just above the ears, overhanging them. In the male these organs are the centre of a spot of brilliant orange, which extends a short distance in all directions, especially forward, and dies out about three-fourths of the distance to the eyes. The ear opens obliquely forward, is about as large as the eye, and roughly circular. The flap, which is all that there is of the tragus, is fastened posteriorly, opening forward, and must be of very little help in concentrating sound, being small, and useful only in closing the ear in case of need. The whole organ is completely buried and concealed in rather short but dense hair.

I have fired a gun close to a slumbering sloth, and to one feeding and aroused but little attention. This is perhaps due, not so much to deafness, as to total lack of interest in such a noise. I am able at any time to attract the attention of any sloth by giving the characteristic plaintive whistle, although the reaction is of a most languid character except in the case of separated mother and offspring. I have watched sloths when a hawk was flying low overhead, screaming loudly, and neither sight nor sound penetrated the dull aura of mental opacity which invests the senses of these mammals. Again I have known the sense of hearing gradually to assume dominance in a feeding routine. Every morning a tall shoot of cecropia was cut and placed in the enclosure, and the sloth, asleep near the top of his tree,

ould awaken and come down for his breakfast. When I took a particularly large branch, with juicy sprout and new leaves, very quietly to the tree, the sloth would sleep on for another hour or two before he woke, the odor evidently being impotent during sleep. When I came with the usual noise and in place of the tree, elaborately planted a rake, the sloth came down as usual, and went through sorts of painful acrobatic feats before he succeeded in climbing within reach of the prongs, only then, by placing his nostrils close against them did he learn that it was not the cecropia he had expected. Sound, fraught with gastronomic memories, had aroused him, and his ears and sight led him to the usual place, but neither sight nor smell, operating in unobstructed sunlight through a distance of from twelve feet down to one foot, served to save the sloth all the trouble of a difficult climb, and a final narial test at a quarter of an inch distance, of barren iron prongs. For five minutes the sloth clawed at the prongs and stretched his head helplessly in all directions, and then, if overcome by the unusual mental effort, hung himself in the nearest crotch and went to sleep. Such reaction, in the face of wholly inexplicable and complete disappointment, has something valuable in it, from the human viewpoint.

The sense of smell is the only one to which I feel inclined to allot more than a II, and even here III is all that sloths deserve. Even this, however, is more than man can boast, who rightly sinks to a II. I placed a sloth, hungry and not too disturbed, on an open area under the bamboos, and planted four shoots twenty feet away in the four directions of the compass. One of these was cecropia, camouflaged with thin cheesecloth, so that the best of eyesight could never identify it, and placed to the south, so that any direct wind from the east would not bring the odor too easily. The sloth tested itself and looked blinkingly around. The bamboos thirty feet above, silhouetted against the sky, caught its eye, and it pitifully stretched up an arm, as a child will reach for the moon. It then sniffed with outstretched head and neck, and painfully began its hooking progress toward the cecropia. Variations of this yielded complete confirmation of the ability of the sloth to detect its food-plant at a considerable distance by the sense of smell.

Not only is each food leaf tested with the nostrils, but each branch, before the full weight is brought to bear. Again and again I have seen sloths draw back and choose another route, after a moment's close sniffing at a branch, which I invariably found was

decayed, and scarcely, if at all, able to support the animal, although to my eyes it might appear as strong and sound as the one the sloth was on. This is undoubtedly one of the most important requirements in its lifetime, and the existence or extermination of these animals might well rest upon the proper functioning of the sense of smell in this matter of detecting sound and rotten branches.

The nostrils are directed forward, small, simple, round, with the surrounding and bounding skin black, shining, quite bare, soft and constantly moist, the latter a certain indication of effective functioning. The lips are sparsely covered with short, buffy hairs and there are about fifteen tactile hairs on each. The lips are very thick and rubbery, barely noticeable externally, but flat and black within. The upper one is evenly rounded, the lower with two prominent internal tubercles just interior to the two front teeth, and fitting into small cavities in the roof of the mouth, close interiorly to the two upper anterior teeth.

MENTALITY

One occurrence presents an interesting comparison of the interplay of senses, and clearly indicates the level of mentality at which the lives of these mammals are maintained. Near the top of the enclosure tree was a three-quarter grown male asleep; seven feet below him was a mother sloth, from whom I had removed her month-old baby. I placed the infant sloth five feet away from the mother on a horizontal limb at the same height. At once the young sloth began calling, giving the identical plaintive whistle of the adults. Without answering, the mother showed at once that she heard, and her bullet head and marvellously versatile neck were turned and twisted in all directions. Many times she looked straight in the direction of her offspring climbing awkwardly along five feet away. But neither sight, hearing nor smell availed anything. Looking upward, against the sky she discovered the huddled ball of the large sloth, and at once climbed, as rapidly as her sense-bound mind and muscle-bound limbs would permit, straight up to the male sloth, reached out a tentative claw and sniffed with nose close against his fur. One second's test was sufficient, and she descended as rapidly, or as unslovely as she had climbed. The baby had seen his mother from the first and had struggled with all his little might to creep along



Fig. 9. Front view of the head of a month-old three-toed sloth. Photograph by John Tee-Van.



Fig. 10. Sloth in the heart of a cecropia tree, high above the Guiana jungle. It feeds almost exclusively on the leaves of this tree. Photograph by John Tee-Van.

the branch toward her. In spite of his chubby limbs which always kept getting in the way of one another, he made good progress, and was within two feet of the main trunk when his mother reached his level again. Her back was turned as she passed, but his whistles were ringing close to her ears, and his tiny claws caught at her fur as she went down, and yet she gave no heed, but reached the ground, and without hesitation, started out for the nearest edge of the jungle, looking up at each call of her baby and then hurrying on in the opposite direction. I went after her, picked her up by the middle of the back, the only safe place to hold a sloth,—and replanted her on the trunk. This time she was facing the young one, and at his first call, she reached out a tardy arm, he seized it and climbed down it to her body, and both were content. It is almost unimaginable to think of a mammal in full health, which, while actively seeking for its young, would have allowed an interval of five feet to separate her from it forever.

HAIR AND SKIN

The logical placing, in this monograph, of a detailed account of the hair and skin of the sloth is difficult, for the reason that it is equally important from several wholly different points of view, physiological, symbiotical, and as being one of the most important fundamental explanations of the sloth's psychology and vital activities.

In this tropical land of superabundant animal life no outstanding characteristic is developed or maintained without a very deep and real cause, and this is equally true of the most specialized, recently evolved forms of life, as of interesting relics of the past, such as hoatzins and sloths. When we see birds of large size and conspicuous plumage, living exposed to a host of dangers, with weak flight and no defensive beak or talons, we may be certain that there is some compensating factor, hidden, but none the less powerfully operative ontogenetically and phylogenetically, day and night, at moments of safety and of extreme danger. In the case of the hoatzins this is odor,—a musky emanation apparently distilled in the course of the somatic analysis of the food, and deterring the attacks of the carnivores, eagles and serpents which, without such a repellent, could exterminate these helpless birds within a short time.

In sloths we find ten pacifistically defensive factors in operation, all of the utmost importance; first, the living, feeding and sleeping in

fty, often small-branched trees, which would eliminate such heavy enemies as jaguars; second, the form, in repose like ant or termite nests or epiphytes, and in action with much of the animal outline obliterated by long hair, or unusually featured, jointed and graduated head, neck and limbs; third, the pigment mantle of lichens, moss and dead leaves which is drawn over the hair. The coloration may be divided into three distinct sub-factors, *a*, the resemblance of both sexes during the dry season to dead vegetation or to the insect nests mentioned; *b*, the very appreciable greenish tinge imparted, during the rainy season, by the greatly increased brilliance of the symbiotic algae on the hairs; *c*, the brilliant mid-dorsal spot of the male, which, whatever it appears to represent, serves to break up the bodily form of that sex. Fourth, the pattern, which is of importance because of the variability, no two sloths being colored alike, the masculine orange spot, coming under this heading, also more valuable for not being an invariable indication of all individuals of this species; fifth, movement, or that most necessary corollary of protective coloration, the lack of it,—the animals being characterized by a large percentage of immobility, or very slow, deliberate movement, progress from branch to branch being made with absolute silence, noiselessly as a shadow. Sixth, the voice, again to speak rather Celtically, characterized by silence. When, very rarely, a sound is made, it is bird- or cicada-like, and very ventriloquial.

These might be called telegonous factors, or defensive phenomena acting at a distance, through space and the intermediate vibrations of light and sound. Or, to view them from another standpoint, all dependent for effective operation upon the imperfection of senses of the enemies.

The seventh is pose, the rolling up into a tight and firmly sustained ball, protecting the vital parts; eighth, the two dense coats of hair, ninth, the thick and very tough skin, and tenth, the greatly increased number and breadth of the ribs. These three are effective actually, and of course only at closest range.

This bodily armor of hair, skin and ribs I consider the most important of all the defense of a sloth, which indeed, in the last analysis, would determine the continued existence of a degenerate race, such as these animals present today. It makes possible successful competition with a host of creatures, infinitely better provided with perceptual powers and defensive and offensive ability.

Three additional factors of defense form the Active or Dynamic

Defense of these animals, first, progress—an escape, slowly but in any direction, or a more balanced, secure advance through the branches than is possessed by any other arboreal mammal; second, claws used in swinging, scythe-like sweeps of the fore arm; third, powerfully muscled jaws armed with flat, crushing teeth which are used in biting. I have described these two last factors in detail elsewhere in this monograph.

These thirteen lines of defense may be charted thus:

PASSIVE DEFENSE

A—Effective at a Distance	Distance operative	How Operative
1—HABITAT; Isolation in high trees	10-150 ft.	vision
2—FORM; Like termite nest or parasitic plant.	10-150 ft.	vision
3—COLOR; Dry Season, like lichens, moss, dead leaves, bark	10-150 ft.	vision
Rainy Season, greenish like foliage	10-150 ft.	vision
4—PATTERN; Ruptive colored marks in male, irregular in female	10-150 ft.	vision
5—MOVEMENT; Motionless or very slow	10-150 ft.	vision
6—VOICE; Silent, or like bird or insect, also ventriloquial	10-150 ft.	hearing
B—Effective at Close Range		
7—POSE; Rolled into complete impenetrable ball, locked by claws		muscular resistance
8—HAIR; Two coats, very dense		hair resistance
9—SKIN; Thick and very tough		skin resistance
10—SKELETON; Ribs numerous and broad		bone resistance

ACTIVE DEFENSE

11—PROGRESS; Climbs slowly but anywhere	any beyond touch	muscular action
12—CLAWS; Slashing hooks with fore arm claws	18 inches	muscular action
13—TEETH; Flat and crushing, used in biting	1 foot	muscular action

Examination of the pelage of the Three-toed Sloth shows two distinct coats, the long, coarse, yet silky hairs which bear the distinctive colors, grey, brown, black, white, yellow and orange of the adult, and the short, fine, wavy, silk-like body coat. The long hairs are flattened to an oval or almost a ribbon, presenting very distinctly broad and narrow sides. The longer, white hairs are more than twice as wide as they are deep, averaging .25 by .11 millimeter. In hairs from living individuals of the Three-toed Sloth there is no

ence of the longitudinal fluting mentioned by many writers as being common to all sloths and unique among Mammalia.

The surface is smooth, ivory-like, with occasional hints of the ridges of the scales, which now and then near the tips show slightly. Sometimes, however, this segmentation of the cortex is pronounced and regular, so that the entire hair is marked with transverse cracks, which may be so wide that the hair looks like a string of closely hung beads. Among two or three hundred fresh hairs I found twelve which showed a decided longitudinal groove, and in each case there was no algae on the surface.

In the Two-toed Sloth the hairs are almost all distinctly fluted, there being usually four ridges and three grooves on each side. These are plainly visible under a 10 diameter lens, and a pile of angled hairs from the two species can be sorted out at a glance. When the arrangement of the algae is distinctive, its distribution in *Choloepus* being longitudinally along the grooves, and in *Bradypus* short, lateral tongues or lines, especially marked in hairs which show distinct cortical segmentation. The soft under fur is round in section, never more than .05 of a millimeter in diameter, colorless, translucent, and quite free from all parasitic or other detritus. It is usually wavy.

The hair as a whole grows very closely together from small tufts, closely resembling the down of nestling birds. These are .2 to .6 of a millimeter apart, and each clump consists of six to twenty separate hairs. These may be all short, soft, under-fur hairs, or a single white or brown or grey hair of the long coat may spring from the heart of such a clump. I could find no long hairs arising alone. They seem always closely associated with the shorter coat. The relative average lengths of the short and long hairs are twenty-five and fifty millimeters, or 1 to 2. Between the eye and ear the hair is thirteen millimeters long, while its maximum length is on the nuchal cape, and on the upper arm, where it may reach one hundred millimeters.

I have casually mentioned the presence of an alga on the hairs of the sloth, and I have never found an adult animal without an abundance of this lowly plant on the long hairs of the pelage. When the sloth is perfectly dry the algae appear only as a dirty brown, generally-scattered pigment, which tones down the ivory whiteness of the lighter hairs. When the fur is wet, and especially after a few hours of soaking, the whole surface assumes a more or less green



Fig. 11. Profile of the head of an adult female sloth. Photograph by William Beebe.

tinge, which in patches may appear of an intense green. We are at once reminded of the relationship between hydra and rotifers, and algae, but direct comparison is impossible: The symbiotic benefit derived by the sloth, while actually from the chlorophyll, is an added pigmental protection in place of interchange of respiratory elements. I have hung up a sloth among green leaves before and after dipping in the river, and it required no imagination to see a very appreciable difference in conspicuousness. This would be of value as additional concealment from enemies flying overhead, but hardly from those looking up and seeing the animal in silhouette.

The amount of algae seems independent of season, but more directly connected with the shedding of the fur. In one individual whose hairs were loose and apparently in full process of being shed, there was comparatively little green, but an abundance of dead algae.

The algae is equally abundant on the dark hairs, grey or black, and the white, the latter being sometimes almost covered. It is most conspicuous on a newly grown white hair, appearing as small, irregularly transverse patches, extending from a quarter to half across the surface. Under lower power they appear homogeneous,

at greater magnification resolves them into distinct pieces fitting each other in outline, but slightly separated. Each has a lighter green centre. The dead algae are of a light purple color and on most hairs are in excess. In the dry hair the apparent loss of green is due not only to actual dulling and clouding of the surface, but the edges of the minute fronds curl up slightly. A water film instantly causes the brilliant color to flash out. There is no trace of this algae on the young sloth up to about four months of age, and then only in tiny, isolated patches.

The direction of the hair on the entire surface is adapted to shedding rain when the animal is in the position of rest, which, as I have elsewhere described, is never normally upside-down. On the dorsal head and neck the elongated cape of long hair is parted in the middle; the direction elsewhere is, body down, upper arm up, forearm, legs and tail down.

The skin of an advanced embryo, which I removed, was as tough as that of an average adult monkey, while the hide of a full-grown sloth is much thicker. The well-worn accounts of the toughness of the skin of the sloth is, therefore, strange to say, not over-estimated. In many parts of the body, the skin of an adult sloth is as much as 5 mm., or a full eighth of an inch thick, and tough and gristly as well. In addition to this, the under-fur is excessively dense, curly and thick, and forms a solid mat, as effective as sandbags on a trench parapet. A skinning knife becomes dull very quickly when used on sloths, and a pair of scissors often turns, as if cutting cartilage.

The multiplication and flatness of ribs of the sloths have frequently been instanced as adaptations to an inverted position, an osseous basket of sorts which serves to relieve the strain on the viscera. Disregarding the fact that less than ten per cent of the entire life of a sloth is spent upside down, it is interesting to compare its body with those of a typical monkey, and of a terrestrial mammal, such as an agouti:

	Agouti	Cebus	Sloth
Weight of animals	6.5	7	9.25 lbs.
Weight of abdominal viscera	1 lb. 10 oz.		3.5 lbs.
Length of intestines	16.5 feet		10 feet
Number of ribs	26	30	30
Width relative to the length	5%	4½%	11½%

This comparison does not sustain the idea of the necessity of increased provision for visceral suspension. On the other hand, when, as we have seen, the chief defenses of the animal are two thick coats of hair and an exceedingly thick and tough skin, we can readily appreciate the advantage of having a third line of defense in the shape of a lattice-work of close-set, hard bones. A direct comparison may be made with the little anteater, *Cyclopes didactylus didactylus* of this same region, whose ribs form an even tighter box of bone.

Teleologically, I should perhaps have introduced the subject of increased number of ribs with a discussion of the correspondingly abnormal number of dorso-lumbar vertebrae, but however that may be, it is at least an indirect factor of importance in the defensive congeries of this superlatively arboreal mammal, for by means of this vertebral flexibility the rolling into an absolute round ball is made possible. When the sloth spheres, the head and neck, both ends of the body and all four limbs, together with the upright branch to which it is clinging and the horizontal one upon which it is resting—all contribute to close the one vital weakness, the unprotected intracostal periphery of the body cavity.

Many a hawk of moderate size must strike in vain at the apparently soft furry body in the crotch of the tree, and I have hung up the fresh skin of one of these animals and fired a charge of shot at it at fifty feet distance, and had many of the shot flatten themselves just below the surface. The difficulty of killing a sloth is really four-fold, the dense pelage, the thick skin, the bony protection and the remarkably low physiological vitality, while even after actual death, the claws will often remain flexed, and thus suspend the body out of reach in apparently living resistance to gravitation.

Sloths live at such a low ebb, in a perpetual aestivation of sorts, that they outrage all the viability extremes of the other mammals, and approach closely the cold-blooded, defective heart-chambered reptiles. I have heard of a sloth living after forty minutes' immersion under water, and have myself seen one recover from a half-hour of complete submergence. I have known a sloth to act normally for a long time after it had received a wound which practically destroyed the heart, and their recovery after less severe wounds, and freedom from infection in lacerations is very remarkable. A sloth which I kept in captivity on a river-steamer apparently died, and showed no signs of life. I stuffed its mouth with cotton and placed it on ice in the ship's refrigerator, and next morning, after an hour's thawing in

the sun, preliminary to skinning, the animal began to show coordinated movements.

ENEMIES

To sum up, and to introduce the subject of enemies, the great natural timidity, the remarkable protective characters apparent in pattern, color, form and posture, and the ability to defend itself in a fashion in the last extremity, all point to a life surrounded by many potential dangers, and it is probable that more creatures than we know, attempt to kill these handicapped mammals. A direct comparison may be made between sloths and their unlike but undoubted relations, the armadillos, the possession of a protective epidermis. And while this is not carried to the extreme of the armored Dasypodians, yet it is a very real defense. The cringing from attack into an arboreal ball is another armadillo-like character, and few raptorial birds except the mighty-taloned harpy eagle could successfully injure a sloth in such a position. This conventionally accepted hostile association of sloth and harpy eagle, in the rôle respectively of victim and assailant, has been quoted and requoted in almost every natural history story and book of travel. I can verify a widely accepted fact as to the basis of fact, for I have shot an immature harpy eagle with wads of three-toed sloth hair in its stomach. On a heavy branch or near the ground, a jaguar would make short work of a sloth, rolled or unrolled, but an ocelot, while its claws would make grievous scratches, would have no easy matter to maintain its footing high up in a tree and at the same time dislodge the hold of the sloth's strong claws. A man unaided cannot pull a sloth off a branch by direct force.

I can add the anaconda as a definite enemy, for I once found a sloth's skull among the few recognizable stomach contents of a large snake of this species which itself had met death in some unknown way, and was almost returned to its various elements. Again a red-tailed cat had bolted the unmistakable tongue and upper windpipe, but this was undoubtedly a relic of scavenging after a harpy's cast or that of some other more probable victor. The whole lower jaw and manus of a very small three-toed sloth was found among motmot's feathers in the stomach of a margay cat, while the animal itself had a terrific gash across one side of the face, perhaps given by the mother sloth while the young animal was being attacked. This carnivore, while no larger than an ocelot, is much more arboreal, and

as I have found the remains of a cebus monkey in its food, I can well believe it capable, under favorable conditions, of tearing a baby sloth from its mother.

From more subtle enemies such as parasites, sloths seem remarkably free internally, as vegetarians usually are, and externally, probably as a direct result of the dermal and epidermal barriers. I have never known either young or old to be afflicted with bots, but I have seen them extremely annoyed by the large red bees, *Xylocopa fimbriata*, trying to alight on the nostrils, attracted by the moisture on the surface of the tissues.

The only true parasite I have observed on these animals is a species of large and ornate tick. This creature frequently comes to the tips of the hairs and crawls about in full view. One mother sloth which I kept for a long time in captivity had six of these acarids on her body, and when her six-weeks-old infant died, I found four of the ticks in its fur. The ticks are 8 by 5 mm. in length, pear-shaped, flat, and of a rich russet brown, variegated on the back with golden yellow, dotted with brown. There is a swollen, rounded rim extending clear around the body, thickest along the posterior half, where it is divided into about a dozen radiating segments.

These three animals, a mammal, a bird, and a reptile, sum up my knowledge of the sloth's enemies. The fact that the sloth is asleep and motionless on a lofty perch during the night, makes it less likely to fall a frequent victim to prowling jaguars, while its diurnal habits and usual exposure skyward would make it likely that all the hawk eagles which pass must have opportunities of perceiving and attacking them.

Tough and thick as the skin is in general, there are spots which are vulnerable to tiny annoyers. This is easily seen when a splintered branch of cecropia is given a sloth, out of the nodes of which a swarm of tiny Azteca ants are pouring. Soon after feeding is begun, the sloths show signs of restlessness and sometimes the host of little stinging demons actually drives the sloths away. The latter then suspend themselves by their hind claws and begin a frantic but wholly ineffectual scratching of the whole of their heads and bodies, their claws ploughing wildly through the fur in all directions. The ants are certainly able to force their way down through the dense inner fur and at certain points to penetrate with their diminutive stings to nerves in the skin.

Neither thick skin nor dense coat of hair serves to protect the

th from the full glare of the sun, and a sloth given no shade will within four days, as I found to my regret when I was a greenhorn in knowledge of the ways of sloths. Once when I had no facility for a sloth to climb about, I confined an animal in a box and in three days its feet were so raw from the unaccustomed pressure, that it took as many weeks of care to get the sloth into condition to be photographed.

FRIENDS

The innocuous character of the sloth is apparently a matter of common knowledge among birds and other arboreal creatures, for they show absolutely no fear of them. I have seen small birds feeding unconcernedly within five or six feet, and flycatchers and manatees will often come close to have a good look at the inverted creatures, as if surprised as much as we are. Aside from this tolerance, the sloth itself is too self-centered, too subreptilian in mentality to be able to conceive any relationship with its tropical arboreal neighbors other than patiently to await their approach to see whether they themselves are to be ignored or doomed.

INTER-COMMUNICATION

The native name of *ai* for the Three-toed Sloth is onomatopoeic, but no syllables or vowels will serve to represent their strange utterance. They are unnecessary, for it can be imitated almost exactly by a simple whistle. I have never heard it from the adult except when the animal thinks itself in extreme danger. Sometimes when I come suddenly up to one of my sloths and stroke it, the cry is given, or when I unhook it from a branch, and once when I tied it up in a sack so it could have its portrait painted, it called continuously. The young sloth also calls when separated from its parent, and when placed by itself on a branch, or on the ground, continues to call until rescued. The mother never answers during her search for her offspring. The young are easily reassured, and the moment they secure a firm grip on any satisfactory surface, hair, clothing or flesh, they cease crying.

There is little difference in tone or timbre of the cry of a new-born sloth or fully adult sloths of either sex. It is a plaintive, shrill, penetrating whistle, beginning on D* above middle C and holding true for several seconds.

My attention was attracted one afternoon to a moderately tall tree by the cry of a sloth on it, the call being given five times without any apparent reason. Although I have seen these animals courting

in captivity, and enraged, advancing to their pitiful attack, yet neither of these emotions, nor the loss of their young, ever moved them to utter a sound. Except in the very young animal the cry is given through the nostrils with the mouth closed, yet when heard near at hand, it is almost painful in its shrillness. Its duration is never more than two or three seconds, and the farthest I have ever been able to hear it is two hundred feet. It is very similar to the ordinary call-note of the small-billed kiskadee flycatcher, *Pitangus lictor* (Licht.), and I have been deceived many times and gone to the sloth enclosure to see what was the matter when it was only one of these birds calling from a neighboring tree. Of still greater interest is the reaction of sloths themselves to this bird note. Three separate times I have seen one, five and two sloths respectively, raise their heads and gaze intently in the general direction of the flycatcher, very evidently deceived by the resemblance.

Taking into consideration the extreme dullness of the other senses of the sloth, I believe that the voice is of equal or greater importance in enabling these animals to find one another in the mating season. I have had, however, no first-hand evidence of this. Vocally, the sloth occupies a very low place among mammals, both in physiological specialization and in variety of expressed emotions. Also it is interesting to observe that the young shows no improvement in the matter of voice, so its character is not due to ontogenetic degeneration.

The cry of a sloth is very high in the scale, dropping slightly at the end, and is not far from the upper limit of human whistling. A most interesting thing is the way their hearing is exactly attuned to this note. I once placed two mother sloths in a cage, and took away their offspring. Going sixty feet away I gave the call. Slowly but surely both heads turned in my direction and a male high up on his tree also turned at the same instant.

This tone was upper D*. I then waited a while and gave upper C, then E, then upper B with no result whatever. Again I whistled D* and the reaction was as instantaneous as a sloth can achieve. With difficulty I whistled higher, then began at C and whistled a sudden rising scale as high as possible, arousing no attention. I repeated this on different days, with various individuals and found that while unattached sloths paid no attention to a note above or below, an anxious mother sometimes looked around at half a note below. But usually even D had no effect, while D* aroused all

the interest which their poor, dull minds could bring to bear. When he is attacked by another sloth the victim rarely utters this absurd whistle of a cry. It is their only vocal expression of emotion.

FOOD AND FEEDING

I have made a great many tests with plants of various families and have found no food acceptable to the three-toed sloth except cecropia or pump-wood, *Cecropia palmata*, and wild plum, *Spondias mombin* Linné. The latter is refused by some individuals, and when the two are offered, the plum is never touched. The leaves only, of the plum are eaten, but besides the cecropia leaves, the leaf buds, terminal shoots, petioles, and the main stem itself, where it is still green, are devoured with relish.

When I put a large cecropia shoot in the sloths' enclosure the method of feeding of different individuals in various months or years is exactly the same. The sloth, if asleep, is awakened by the rustle of the leaves, and slowly unwrapping itself, climbs down. When near, it reaches out a long forearm and hooks in a leaf, drawing it around until the tip is within reach of the slit-like mouth. Or if all the limbs are in use, the head is stretched out and twisted until the edge of the leaf is encountered. The chewing is continuous, one or occasionally two bites every second, and as the leaf substance is digested, the head is shifted laterally. Thus the entire lobe is gradually devoured by a series of lateral swings. Unless disturbed, there is no break, and the swallowing is wholly incidental, there being not the slightest indication of it in the regular rhythm of chewing. There is no lateral movement of the jaws, the bite being direct, and the separated leaf tissue removed by successive forward and back movements of the tongue.

Considering the size of these animals, the amount of food they consume is surprisingly small. I once tested the weight of fodder taken by a young fawn of *Mazama nemorivaga* (F. Cuvier), and although the weight of the deer was exactly that of a large Three-toed sloth, yet the amount of food consumed was seven times as great. Some sloths feed only every other day, and now and then a three-toed individual will be captured which refuses all food and starves to death after two or three months' fast. This is very seldom the case in their native country, but this species will not adapt itself to any strange diet, and so is wholly unsuited for captivity in northern zoological parks. The two-toed, on the contrary, feeds readily on



Fig. 12. Mother and young three-toed sloth, the parent in full movement. Photograph by William Beebe.



Fig. 13. Mother and young two-toed sloth. Observe shorter fore-limbs and longer hair. Photograph by Elwin R. Sanborn.

fruit and vegetables, especially bananas, and bread and milk, and has lived for years in the London and New York Zoos. I have never seen a sloth drink, and it is probable that it obtains sufficient moisture from the tissues of the leaves. Morning and afternoon are the regular times of feeding, although on cloudy days I have seen them eating at midday, and occasionally late at night in full moonlight.

The lips are flush with the outside skin, and flat on their apposed surfaces. They are thick and leathery, and the irregularly disposed, small tubercles, which are scattered over them, together with the two larger projections on the center of the lower lip all aid in holding fast the leaf while it is being chewed off. The tongue is pale flesh color, large, thick and soft, reaching quite to the lower lip, filling the whole space between the two rows of mandibular teeth, and extending well in front of the anterior teeth which are 8 mm. apart. The upper surface of the tongue is tumid, with three deep, longitudinal furrows and several, shallow, obliquely-transverse ones. The entire surface is densely covered with minute, transparent, sharp, backward-directed spines, averaging twenty-five to a square millimeter, and extending back almost to the level of the angle of the lower jaw. The tongue measures about 35 by 11 mm., giving about ten thousand spines in all. The organ is thus a most efficient ingesting apparatus, and explains the possibility of continuous, uninterrupted chewing, while the bitten off portions are carried back and down by the tongue.

Not only the inner lining of the lips, but the circumdental tissue, the roof of the mouth, and asymmetrical lingual blotches are black. The palate is roughened, and covered with a number of coarse, irregular, raised ridges, short, and more or less transversely oblique. In the upper jaw are five teeth on each side, four isolated, rounded, molar-like teeth, hollowed in the center, and a fifth anterior pair, peg-like and solid with the upper surface worn obliquely backward. These are wide apart medianly. In front lies the semi-loose, cartilaginous premaxillary, toothless, with only a complexly folded bit of black, terminal, palatal lining between it and the mouth. In the lower jaw are only four teeth on each side, all of the concave rounded type. The chin and lower jaw are remarkably deep, affording excellent attachment for strong chewing muscles. The depth is equal to the distance from the line of the mouth to above the eye.

The hyoid is intimately connected with the ear, and is separated only with difficulty.

Digestion, like the other physiological and the mental processes, is slow, much more so than in other herbivorous mammals. The mouth has no great gaping power, and is slit-like, well adapted to receiving and chopping off the flat surfaces of leaves. The animal has much more trouble when it begins to feed on the good-sized, round stems. The oesophagus is small in calibre and short. The stomach is very large, about 120 by 100 mm., and very complex. In the large anterior compartment the leaves form a finely comminuted, pale green, moist mass, while in the enormous coecal diverticulum, they are still green, but almost dry, while in the intestine the ingested material consists of blackened, dry fibre. The excrement is in the form of small oval pellets, about 10 by 5 mm., and, at least after a diet of cecropia leaves, is composed of matted, black, cellulose fibres.

The liver is relatively small, high up on the right side, closely applied to the dorsum and to the diaphragm, 75 by 55 mm. and 20 thick. The lobes are closely united.

The large intestine is 80 mm. in length and merges gradually into the small intestine. This has a total length of 1925 mm. or 6 feet, 4 inches, and is of rather small, even calibre throughout. The bladder is very large, sometimes 120 mm. in diameter.

ROOSTS

Sloths sleep at least twice as much as any other mammal with which I am acquainted. One nearly grown male in good color and health, eating regularly a full quota of food, lived for months just outside the laboratory. I timed his activities for a week, occasionally looking, or going out at night, and keeping a close watch on him during the day. His existence on earth during that period of 168 hours was divided into 11 hours of feeding, 18 of aimless climbing about, 10 of resting and looking about or lazily scratching, and 129 hours of sleep, an average of $18\frac{1}{2}$ hours each day. What an ideal life for some people!

Sloths have favorite sleeping places to which they return regularly. I have seen this occur five times in succession in the case of a sloth at liberty, and for many weeks in animals in confinement. No attempt at a nest or shelter is made, and no protection sought against rain or sun other than the jungle foliage.

I have never seen a sloth sleeping upside down, except in a cage

here there was nothing but a horizontal bar to which to cling. The first desideratum is a vertical branch or stem. Upon this the sloth will settle to rest by taking a firm grip with all four feet, letting its limbs hang obliquely downward, turning the head and neck forward and in between the front legs, and setting the tail firmly against the side or front of the support. When given opportunity to choose, all sloths adopt identical sleeping poses. They seat themselves upon a sloping or horizontal branch, gripping with both feet the upright stem to which it is joined, head curled down upon the chest in front, and both forearms curved around head and body. To such a roost and pose they return on every possible excuse. I have had a sloth wholly occupied in trying to injure me with languid hooks and still more desultory bites, when at the first drop of rain, all wrath was forgotten, and he climbed without hesitation to his regular roost. In heavy wind, as well as after feeding, they retire to it at once, and for the night, early every afternoon, while they leave it reluctantly, long after every other diurnal bird and mammal, including ourselves, are abroad and doing.

The roost I have described is the only home a sloth can be said to have. Once a pile of sign on the ground indicated a long stay at such a place. I cut down the tree, and found deep grooves where the claws had cut in during sleep. Cecropia trees were abundant close by and it is probable that this particular crotch was occupied for at least three weeks. The cecropia is the dining room of the sloth, the mid-height jungle is his estate, while his highway lies beneath his limbs. No wonder it has survived from ancient times without need for keenness of sense; no other creature in the world would dispute either food, paths or sleeping place.

COURTSHIP

I have watched two courtships, one of an immature male and the other of an animal of full size and color. Both were alike in their absolute directness and simplicity. The male climbed up to the female and when within reach, stretched out an arm and attempted to pull her down, exactly as he would haul in a cecropia leaf. In the first instance where the female had a month old baby clinging to her side, she lunged leisurely with full force at the disturber of her peace. The other female simply mounted higher, and when she could ascend no more, she climbed down and across her suitor, leaving him stranded on the lofty branch looking vaguely about, and reaching



Fig. 14. Three-toed sloth; embryo within a few days of birth. Photograph by John Tee-Van.

at in vain toward a big green iguana lizard on the next limb in mistake for the fair companion of his tree. This unemotional pursuit continued for an hour, when he gave up for good and went to sleep. Throughout it all, although he was as enthusiastic as a sloth could be, not a sound was uttered, not a feature altered its stolid repose,—the dull eyes only blinked slowly and the head moved mechanically, striving to pierce the opaque veil which ever hangs between its brain and the sights, sounds and smells of this tropical world. The orange ear-spots, and the brilliant mid-dorsal sun painted upon the fur of the male were ever of any value in courtship, it was ages long past when the ancestors of sloths, contemporaries of their ant relations the Mylodons, had better eyesight to escape from bare-toothed tigers, than there is need for today.

The courtships, like the restlessness of the migrating males, take place in the tropical spring, in March and April, before the beginning of the long rains, and the births of ten young of which I have data, were distributed as follows, July 2, August 7, and September 1. I have reliable reports of very young sloths in May and October, so there may be considerable latitude in the extreme of the breeding period.

To sum up the general phenomena of this phase, the male makes no use of his bright colors, or any other secondary sexual character, and his courtship is unemotional, direct and brief. I have no shred of evidence that he exhibits any interest whatever in the young, nor in fact, that he remains in the company of the female for more than a few hours.

YOUNG

Only a single young sloth is born at a time, and although I have made many inquiries in various countries I have never heard of an exception. As a rule they are born at the beginning of the long rainy season, late July, August and September, with the focus of births about August 1st. Sloths dislike rain and their hair soon becomes drenched through in a heavy downpour. They often give up feeding rather than climb about in a severe rain, and a mother sloth will go without food two days rather than uncurl and expose her young animal to the wet. This is probably a factor in the season of births, coming at the beginning of four months of least rainfall.

I have never had a sloth born in captivity but I have had them a week old, and have taken an embryo within a week of birth. When the latter was washed and dried, except for the dulness of its eyes, it could not be told from a one or two-week post-natal individual.



Fig. 15. The same embryo as in Fig. 14, dried and relaxed to show perfection of development at this stage. Photograph by John Tee-Van

There is considerable difference in relative dimensions among young sloths, and the individual variation in color and pattern is as great in the adult.

The first coat of hair of the young sloth is so well-developed in the late embryo, that, as I have said, it cannot be distinguished from that of an animal many days old. The hairs are very soft and fine, even softer than in the adult. As to length, on the top of the head the length is 23 mm, at the elbow 30, on the midbreast 26, on the knee 23, and on the mid-back 30 mm.

With the exception of the nostrils, the sub-nasal lip area and a narrow line down the sole, from claw base to heel, every part of body and limbs is clothed densely with hair. The pelage, as a whole, differs from that of the adult in the greater quality of length of the two coats. Where the longer coat is 30 mm., the under fur is 25 mm. This accounts for the greater softness of the juvenile covering. In the six-weeks sloth, a radical molt is perceptible. The whole body shows active growth of a multitude of the thicker, longer hairs, averaging at this age, only a third in length of the functioning natal coat. This change is especially noticeable on the parts which have suffered the most wear, such as the palms and the inner side of the forearms. Here there is a solid coat of this new fur, conspicuous by reason of its white and pointed tips.

The most marked differences between adult sloths of opposite sexes are the brilliantly colored aural and mid-dorsal spots in the male, and the greater development of the mat of hair on the head and neck of the female. The males are also considerably smaller than the females. The young male sloths show none of the external pigmental differences, but are wholly like the female in pattern and pelage. Even at birth, however, the males average smaller. The dominance of the under, wavy fur gives to the long hair of the head and neck a more disturbed, frowzy appearance than the sleek, smooth started mop of the adults.

The individual hairs are, if anything, flatter than in the adult, but average smaller in calibre. They are, as a whole, of a uniform straw color, with the light dorsal patches composed of hairs abruptly white, with enamelled surface, showing no trace of algae until after the second month. There is no hint, not only of longitudinal fluting or grooving, but even of transverse segmentation.

The normal position of the infant after birth is flat upon the mother's ventral body, with limbs wide-spread sideways, gripping

her long hair on the sides of the body. From this point of vantage, by a turn and twist of his mobile neck, he can reach either breast, the glands being placed high up and well to each side of the middle line. He can also turn his head directly backward and look at the scenery, upward, if his mother is climbing along a horizontal limb, or around at the horizon, when she is sitting upright in the resting or sleeping pose. Until a month or more old the young one seldom if ever leaves this refuge under the parent's body, and even after that I have never seen him sprawled for any length of time in a corresponding position on her back, as is so frequently described in the casual observations of travellers.

The strength of grip of baby sloths is unbelievably strong and whenever I have occasion to pull one off quickly, four large tufts of hair come with the claws, showing how tightly he grips the fur.

No matter whether we are interested in sloths from embryological, ontogenetical, or physiological points of view, if we are human, we cannot escape the charm of these little fellows. Next to young bear cubs, which they resemble in many ways, they are the most amusing and delightful of pets. They show no fear, and cease their plaintive wails as soon as they can get all four feet fixed in one's clothing. The vacant expression, which in the adult is one almost of idiocy, becomes infantile and quite suitable to these tumbling little bundles of grey and white fur. They take milk from a medicine dropper readily, and after a few weeks will contentedly munch leaves from the hand.

On the sixth or seventh day the young sloth begins a series of gymnastics, by freeing one or both his front limbs and leaning backward, sometimes completely reversed, or also stretching far to one side. This phase of activity reflects much of the adult movement, which corresponds to the progress of a legless man. The hind legs are passive followers of the front ones, and almost never venture to lead or reach out for a grip of their own. For a few days the young animal revolves about the grip of his hind legs, extending into the most amazing attitudes, and often hanging with his head dangling far out between the mother's knees and body. After courage has come to clamber about he deserts this hydra or leech-like attached movement, and for a few weeks, becomes much more of a balanced quadruped than his parent, and at this time the limbs are correspondingly different in proportion, being more equal in length. The whole mother now becomes his tramping ground, and when she is



Fig. 16. Adult female three-toed sloth. Observe lichen-like marks, well developed tail and rain-shedding slant of hair. Photograph by John Tee-Van.

quiet, he climbs about, sometimes over her head and face, while she suffers patiently his sharp little claws on her eyes and nose. He fumbles his way out to the top of an outstretched arm or leg, and when the parent is weary of his activity, she sweeps him back with one circle of her arm. Nothing could be safer than his normal position, for when she rolls up, with head down and forearms crossed over all, the baby is in the very heart of the ball which she forms, and she can swing with one or both claws and forearms without exposing him to danger.

After she has fed heartily and especially if the day is warm and rainless, she often lies on her back along a branch both feet gripping tightly, forearms partly raised and spread out, with head and neck blocking up the anterior gap. In this living cradle, hollow and lined with the softest fur, the infant sloth approaches play as nearly as these solemnly dull creatures can. He seizes a tuft of hair on her neck and makes comic little swings at her fur, with first one arm, then the other. In doing this he often actually stands up for a minute, holding on with all four feet, and with hind legs very much spread and unsteady. It is only a temporary and passing feat, but the old sloth cannot do it even for a moment, and we have in it a hint of the long past ages when sloths could shamble upright along level ground.

The senses of the young sloth are keener than those of his mother, and he perceives my approach before she does. If the animals are newly caught, his reaction is to lean forward, and look curiously at this strange being, who does not walk upside down along a branch. She, on the contrary, rolls up, closes her eyes, and enfolds him in the depths of her body and limbs. After several weeks in captivity the parent pays little attention to my presence, and allows me to play with the youngster, showing her usual stolidity and lack of interest. His sense of smell is less acute than hers, but his hearing is much better. I found it difficult to get a full-timed photograph at first because of the instantaneous reaction of the young one, his whole body quivering and giving a sudden jump at the noise of the shutter. The sloth cry, too, will attract his attention at greater distance than it will one of the adults.

About the third week the young sloth begins to claw at the face and mouth of the mother. For some time I could make nothing of this, as it was too persistent and studied for play. I watched, and one morning, after five minutes of this teasing, with the infant open-

ing its small jaws and licking the mother's mouth with its little red tongue, I saw a glint of green, and realized that the young sloth was reaning itself from milk to predigested cecropia leaves. I am certain that the mother had not fed since the afternoon before, as she had not changed her position near the top of the branch, and the leaves given her at dusk had not been touched. Later I verified the fact that unless she held the chewed leaves in her mouth for fourteen hours, which is absurd, there must be actual regurgitation. The digestive processes are so slow that the food would still be available from the anterior part of the stomach after such an interval of time. I secured a bit of this vegetable pap and found it of the same consistency and alkalinity as the contents of the organ mentioned in recently killed sloths.

Young sloths, according to my observations, begin eating tender leaves and even chewing at stalks when five weeks old, and thereafter for a month or more the pampered youngster may choose between a milk diet, predigested food or fresh green cecropia leaves.

When about a month old the baby sloth leaves its mother for the first time, in one instance clinging to a huge cecropia leaf which it was mumbling with but slight success. When it reached around and found no fur at hand, it raised a wail which drew the attention of the mother at once. Still clinging to her perch, she stretched out her fore limb to an unbelievable distance, and gently hooked the great claws around the huddled infant, which at once climbed hastily up the long bridge and tumbled headlong into its natal hollow.

A young sloth never flinches from an attempt to free it from its mother's fur. It hangs on for dear life, but when the last clawful of hair comes away, it rolls around in one's hand and reaches hopefully for some new grip on clothing or flesh. It has no knowledge of rolling up into a ball or of hiding its head on its chest. It ceases calling after a few seconds and only worries if it has not twelve clawfuls of something. More than once when playing with a baby sloth it has drawn back and struck out right manfully at me.

Even week-old youngsters are painful to handle incautiously, for their grip on flesh is a pinch between claw tips and sole and the claws are slender and very sharp. The whole grip is unlike that of the adult, and is fitted for gripping a small tuft of hairs rather than a branch. When separated at an early age and forced to fend for themselves on a branch they are extremely unhappy and make very poor progress. The effort is constantly to put the whole arm on the



Fig. 17. Same as Fig. 16, lower view. Photograph by John Tee-Van.

branch and get on top. The inverted position is certainly not so unusual a matter to the young as to the old sloths. They have difficulty in not stepping on their own claws, and when once a baby sloth has secured a grip on the hair of his own arm or body, he lets go of the branch with perfect confidence that hair is a better support than wood.

On the ground young sloths are quite helpless, and roll and tumble about in one spot without ever getting anywhere. This would seem to be a contradiction of the unusual quadrupedal ability which they exhibit on the body of the mother. But as a matter of fact the facility which adult sloths exhibit in getting over the ground is due to their complete divorcement from ordinary quadrupedal structure. When they were less specialized for arboreal life they progressed on the ground in an entirely different manner. This leaves the young hopeless on the ground, for while any remaining avistic instincts or structural memories make for gathering their limbs under them, their proximity to adult sloth morphological conditions negatives any such accomplishment. One difficulty is purely a juvenile adaptation, the difference in the grip from that of the adults, for the young animals seem unable to stretch the claws straight out, having no use for such flexion in their progress about the mother's body, while this hooking of the claws in the ground is the most effective factor in the old sloth's terrestrial progression. But the principal reason is what we might call their positive pelage-topism. The moment one of their claws touches their own body, they seize the hair and hold on through all the subsequent efforts at progress on the ground. The tail is a favorite point of seizure, and when one hand is gripping this organ and the other is stretched around the body holding tight to the leg on the opposite side, the little creature might be shackled and bound for all the use his limbs are to him; his small face grovels in the dirt but it never occurs to him that he might better his condition by letting go of himself.

Even in these comically abortive efforts we perceive an interesting corollary with the limbs of the adult, since only the fore legs are used to feel about and seize upon objects, while the short, stubby hind limbs stick straight out absurdly on each side of the body like a badly made doll, and function only in furnishing occasional anchorage for the forearms. The tail comes into use in helping to turn the young sloth over when on its back, functioning exactly like the hind legs of a scarab beetle in the same predicament. The tail twists

	BRADYPUS Three-toed Sloth						Choloepus Adult 2-toed Sloth	Choloepus Adult Male	Alouatta 3 Weeks Old	Alouatta Adult Female	Cebus 3 Weeks Old
	Late Embryo	2 Weeks Old	4 Weeks Old	6 Weeks Old	8 Weeks Old	10 Weeks Old					
Weight			310 grms.		2040 grms.		9½ lbs.	8 lbs.	9½ lbs.	12 lbs.	7 lb.
Length, head and neck	85	89	150		165	175	200	165	165	62	84
" body	114				265		390	505	470		
" tail	35	47	50	57	70	85				270	620
Diameter tail, half-way	20	20	20	21	27	27				11	15
Sitting height	190	200	420	380	500	500	470		190	480	390
Bimammillary diameter			70	90	72	73	43		46	100	60
Mammary glands from arm-pit			32	38	55	58	26			17	
Chest, transverse diameter	44	44	43	110	100	100	125	100	90	70	110
" sagittal "		40	41	94	90	87	225	95	85	52	112
" circumference		130	135	290	270	290	320	280	300	160	310
Arms and claws, total length		162	164	405		455	480	450	430	160	370
Arm-pit to claw tips	123	140	150		330			430			
Upper arm, length	51	60	65	160	140	182	190	160	175	63	152
Fore arm, "	54	59	62	155	134	176	190	180	200	64	146
Hand, length	39	43	39	76	73	79	74	103	105	60	105
" breadth		12	13	26	20	27	26	24	20	19	28
Hand claws, length	17	20	18	47	42	59	60	54	50	5.5	10
Legs and claws, total length		120	130	265		295	315	400	400	175	400
Thigh to claw tips	83	100	108		200						
Thigh, length	37	39	43	100	86	112	117	138	156	63	170
Lower leg, length	33	40	45	96	86	105	100	160	156	63	150
Tibiale to sole		50	50	115	100	126	127	177	175	77	166
Foot, length	39	47	48	98	68	101	105	110	110	73	131
Foot claws, length	17	19	20	35	33	49	53	44	48	5	8
Foot, breadth		18	18	27	21	32	27	24	25	17	41
Head, total height	34	37	54	60	57	62	76	75	75	75	97
Ear to ear, transverse arc	40	50	85	100	80	100	195	140	140	70	90
Auricular height of head	17	17	24	22	27	36	40	40	40	25	21
Occipital to forehead	40	42	63	61	70	73	90	90	90	62	80
" " lips	47	51	53	78	77	90	88	115	120	79	128
Ear, height			10		10	9	21	28	32	38	41
" breadth			8		7	10	23	33	27	20	27
Interocular	19.5	19	16.5	30	27	31	30	47	45	12	19
Eye, diameter	5.5	6	7.5	9	8	10	11	12.5	12	13	14
" divergence		23°	24°		25°		25°	34°		4°	
Internasal	2.5	2.4	4	4	4	4	4	12.5	11	5	10
Narial diameter	2	1.8	3	3	4	4	4	5.3	7	4.5	7
Mouth, width	19	23	32	31	35	39	47	42	24	34	36
Nasals above mouth	2.5	3.3	5	5	7	6	11	11	11	5.5	11
Eye to ear	16	22.5	31	34	31	42	52	55	30	49	28
" " nares	10	11	17	14	18	16	31	33	11	25	28
Adpressed arm (minus claws)											
		20 mm. beyond tail	Half-way to tail tip	27 mm. beyond tail-tip	Roof of tail	To tail tip	Half-way down tail	80 mm. beyond body	To end of body	20 mm. beyond root of tail	To thigh, 50 mm. short of tail

out strongly in every direction, and I found that, as far as strength went, it was quite sufficient to support the entire animal, when it was turned up over the back. This organ is surprisingly muscular, and in the adult in motion, is never quiet, pushing and feeling about quite as much as the limbs. When the young sloth is lying quietly upon the mother's fur, the tail is often slowly wagging from side to side. It is relatively twice as long in the young as in the old animals.

When, on the ground, the baby sloth succeeds in sitting up for a moment, and reaches up toward your hand with both its small arms, and utters its appealing wail, it requires all the abstract, hardened desire for more knowledge of its activities to keep from restoring it once to its mother. At such a time its resemblance to a bear cub is most striking.

The moment a baby sloth dies and slips from its grip on the mother's fur to the ground, it ceases to exist for her. If it had called she would have climbed down and hooked a claw around it, but simply dropping silently means no more than as if an entangled burr had fallen from her coat. I have watched such a sloth carefully and have never seen any search of her own body or the surrounding branches, or a moment's distraction from sleep or food. An imitation of the cry of the young will draw her attention, but if not repeated she forgets it at once.

ANATOMY

Notes on the Anatomy of a Four-Weeks-Old Male Sloth

Immediately after death I made the following brief notes on the anatomy of a male sloth, about a month old:

Diameter of eyeball 8 mm.

Weight of skin 75 grams; skinned body 235; total weight 310 grams.

Tongue measures 23 by 10 mm. One square millimeter of the surface contains seventy-two teeth, making a total of lingual teeth about seventeen thousand five hundred.

There are eight teeth in each jaw; the two anterior upper teeth not breaking through, not yet functional.

The heart measures 21 by 44 mm.

The lungs are large for the size of the animal, 31 mm. wide, by 33 thick, 25 long anteriorly and 44 mm. posteriorly.



Fig. 18. Three-toed sloth, four weeks old, back view. Observe symmetry of lichen marks, lost in the adult, and different moulding of hind legs, adapted as yet to clinging to the body of the parent, rather than to climbing. Photograph by John Tee-Van.

The larynx is 35 mm. back of the snout, and the two concave cartilages are applied closely against the roof of the mouth. From the larynx down into the thorax, the trachea extends to the middle of the lungs, a distance of 95 mm., and then turns sharply upward, ventrally, back upon itself for 16 mm. It then describes a small, but complete circle also ventrally, and enters the lung tissue proper.

From the larynx to the thorax there are 52 thoracic rings, 3 mm. in diameter; from the thorax to the disappearance into the lung tissue, 48 rings, making a total of 100 tracheal rings. Looking down on the ventral aspect of the opened, undisturbed body cavity, the bladder appears very large, filling the whole lower half of the coelom between the pelvis and the sternum, diameter 33 mm., length 55 mm. The large intestine is 35 mm. in length, merging very gradually into



Fig. 19. Same as Fig. 18, lower view. Photograph by John Tee-Van.

the small intestine which is 800 mm. long and 5 mm. in diameter. The stomach occupies the upper right quarter of the visible coelom, and the intestine the upper left quarter, a superficial area of 50 by 42 by 25 mm. thick. The liver is just visible at the anterior edge of the upper left quarter. Upon examination it is found to be trilobed, 33 long, 33 wide by 12 mm. thick. The kidneys measure 18 by 13 mm.

In a two-weeks-old baby sloth the bladder is as large as in the above specimen, occupying quite half of the open, ventral, intrasternal coelomic area, from the breast bone to the pelvis. Somewhat more liver is visible.

In an adult female sloth, the lungs are 85 mm. long, the larynx 10 mm. back of the snout, the recurved tracheal loop 35 mm. long. The diameter of the eyeball is 14 mm. The bladder is small, hardly

at all visible in a ventral view of the body cavity. The stomach is very large, 150 by 120 by 60 mm. thick. The liver trilobed, the whole 90 by 80 by 25 mm. thick. The complete intestinal length is 3945 mm. or just about ten feet, the large intestine alone being 120 mm. in length. The lungs are 140 by 55 by 33 mm. in depth. The trachea, from its entrance into the thorax to the lowest part of the loop, is 155 mm. long; from the loop to the top of the second turn 55 mm.; and from the thorax to the larynx 85 mm.

EARLY LITERATURE

About four hundred years ago, in 1525, Gonzalo De Oviedo in his "Summarie and Generall Historie of the Indies" published perhaps the first extended account of the sloth, appearing to Purchas in his translation, a "strange beast which seemeth a kind of Camelion."

"There is another strange beast, which by a name of contrary effect, the Spaniards call Cagnuolo leggiero, that is, the Light Dogge, whereas it is one of the slowest beasts in the World and so heavie and dull in moving, that it can scarcely goe fiftie pases in a whole day; these beasts are in the firm land, and are very strange to behold for the disproportion that they have to all other beasts; they are about two spans in length when they are growne to their full bignesse, but when they are very young they are somewhat more grosse, than long; they have foure subtile feet, and in every one of them foure clawes like unto Birds, and joynd together, yet are neither their clawes or their feet able to susteine their bodies from the ground, by reason whereof, and by the heavinesse of their bodies, they draw their bellies on the ground; their necks are high and streight, and all equall like the pestle of a Morter, which is altogether equall even unto the top, without making any proportion or similitude of a head, or any difference except in the noddle, and in the tops of their neckes; they have very round faces much like unto Owles, and have a mark of their owne hairs after the manner of a Circle, which maketh their faces seeme somewhat more long than large: they have small eyes and round, and nostrils like unto Monkeyes: they have little mouthes, and moove their neckes from one side to another, as though they were astonished: their chiefe desire and delight is to cleave and sticke fast unto Trees, or some other thing whereby they may climb aloft, and therefore for the most part, these beasts are found upon Trees, whereunto cleaving fast, they mount up by little and little, staying

themselves by their long clawes: the colour of their hair is between
 russet and white, and of the proper colour of the haire of a Wesell:
 they have no tayles, and their voice is much differing from other
 beasts, for they sing onely in the night, and that continually from
 time to time, singing ever six notes one higher than another, so
 differing with the same, that the first note is the highest, and the other
 a baser tune, as if a man should say, La, sol, fa, mi, re, ut, so this
 beast saith, Ha, ha, ha, ha, ha, ha. And doubtlesse, it seemeth to
 me, that as I have said in the Chapter of the beast called Bardati,
 that those beasts might be the originall and document to imbarbe
 horses: even so, the first invention of Musicke might seeme by the
 hearing of this beast, to have the first principles of that Science,
 rather than by any other thing in the World. But now to return to
 the Historie. I say that in a short space after this Beast hath sung,
 and hath paused a while, shee returneth againe to the selfe-same
 song, and doth this onely in the night, and not in the day: By reason
 hereof, and also because of her evill sight, I think her to be a night
 beast, and the friend of darknesse. Sometimes the Christian men
 and these Beasts, and bring them home to their houses, where also
 they creepe all about with their naturall slownesse, insomuch that
 whether for threatning or pricking they will move any faster than
 their naturall and accustomed pace. And if they finde any Trees,
 they creepe thither immediately, and mount to the top of the highest
 branch therof, where they remayne continually for the space of eight
 or ten, or twentie dayes, without eating of anything, as farre as any
 man can judge. And whereas I my selfe have kept them in my
 house, I could never perceive other but that they live onely of Aire:
 and of the same opinion, are in manner all men of those Regions,
 because they have never seene them eat any thing, but ever turne
 their heads and mouthes toward that part where the wind blowest
 most, whereby may be considered that they take most pleasure in
 the Ayre. They bite not, nor yet can bite, having very little
 mouthes: they are not venemous or noyous any way, but altogether
 brutish, and utterly unprofitable, and without commoditie yet
 knowne to men, saving onely to moove their minds to contemplate
 the infinite power of God, who delighteth in the varietie of crea-
 res, whereby appeareth the power of his incomprehensible wis-
 dome and majestie, so farre to exceed the capacities of man's under-
 standing."

Purchas presents another quaint paragraph from "Observations

gathered out of the . . . Bookes of Josephus Acosta, a learned Jesuite who wrote in 1588, touching the naturall historie of the Heavens, Ayre, Water and Earth, at the West Indies; "There is another strange beast, the which for his great heavinesse, and slownesse in mooving, they call Pericoligero, or the little light Dogge, hee hath three nailes to every hand, and mooves both hand and feete, as it were by compasse and very heavily: it is in face like to a Monkey and hath a shrill crie; it climbeth Trees, and eates Ants."

It would be interesting to know when the word Sloth or Sloath first appeared as the name of this animal. It was apparently unknown to Purchas whose "Pilgrimes" was published in 1625. Still earlier, in 1607, Topsell in his "History of Foure-footed Beastes" gives us what is perhaps the first account in the English language, under the title of *Arctopithecus* or Bear Ape:

"There is in America a very deformed beast, which the inhabitants call *Haut* or *Hauti*, and the Frenchmen *Guenon*, as big as a great Affrican Monkey. His belly hangeth very low, his head and face like unto a childe, and being taken, it will sigh like a young childe. His skin is of an ashe-colour, and hairie like a Beare: he hath but three clawes on a foote, as longe as foure fingers, and like the thornes of Privet, whereby he climbeth up into the highest trees, and for the most part liveth of the leaves of a certain tree, being of an exceeding heighth, which the Americans call *Amahut*, and thereof this beast is called *Haut*. Their tayle is about three fingers long, having very little haire thereon; it hath beene often tried, that though it suffer any famine, it will not eate the fleshe of a living man, and one of them was given me by a French-man, which I kept alive sixe and twenty daies, and at the last it was killed by Dogges, and in that time when I had set it abroad in the open Ayre, I observed that, although it often rained, yet was that beast never wet. When it is tame, it is very loving to a man, and desireth to climbe uppe to his shoulders, which those naked Amerycans cannot endure, by reason of the sharpnesse of his Clawes." *

The name Sloth as used for a beast does not occur in the Shakespeare Lexicon, and it may be assumed that it arose between Topsell's writing in 1607 and the first edition of Pat. Gordon's Geography in 1693. Indeed it must have been well before the latter, as school text books do not present newly coined names, but only those of

* (Quoted by J. Ashton in "Curious Creatures in Zoology," pp. 66-67, 1890.)



Fig. 20. Reproduction of a plate of sloths from Captain Stedman's "Narrative of a Five Years' Expedition against the Revolted Negroes of Surinam in Guiana," published in 1796.

comparatively long usage, and wide recognition. It would have come into general use after the slowness of the animal was known to be its dominant characteristic.

Pat. Gordon must have brought joy to many acquisitive minds, and sorrow to numerous schoolboys of two centuries past with his delightful "Geography Anatomiz'd." On p. 390, under rarities of Brasil, Pat. enumerates "the Sloath (term'd by the Native *Haii*, from his voice of a like Sound) but by most Europeans, *Ignavus* or *Pigritia*; and corruptedly *Pereza*, by the Spaniards; so call'd from the Nature of that Animal, being of so slow a motion, that he requires Three or Four Days to climb up a Tree of an ordinary height, and Twenty four Hours to walk Fifty Paces on plain Ground, his Fore Feet are almost double his Hinder in length and when he climbs a Tree, his hold he takes is so sure, that while he hangs by a Branch, he can sleep securely."

Purchas has preserved a paragraph from "A Treatise of Brasill, written by a Portugall" in 1601, regarding the *Priguica* or *Lazinesse*.

"The Priguica (which they call of Brasill, is worth the seeing; it is like a shag-haire Dog, or a Land-spaniell, they are very ougly and the face is like a woman's evill drest, his fore and hinder feet are long, hee hath great clawes and cruell, they goe with the breast on the earth, and their young fast to their bellie. Though yee strike it never so fast it goeth so leasurely that it hath need of a long time to get up into a tree, and so they are easily taken; their food is certaine Fig-tree leaves, and therefore they cannot be brought to Portugall, for as soone as they want them they die presently."

A few decades later, in 1796, we have Capt. J. G. Stedman "Narrative of a Five Years' Expedition against the Revolted Negroes of Surinam in Guiana," wherein he illustrates (page 153) both the Two- and Three-toed Sloth with such naive charm that I have reproduced the engraving, on page 59 of this paper.

His account of the habits of the sloth are far less accurate and more fanciful than those of De Ovieda, written 271 years earlier. He says, "My negroes . . . brought on board a poor animal alive, with all its four feet chopped off with the bill-hook, and which lay still in the bottom of the canoe. Having freed it from its torment by a blow on the head, I was acquainted that this was the *sloth*, called *loyaree* or *heay* by the natives on account of its plaintive voice. It is about the size of a small water-spaniel, with a round head something like that of a monkey, but its mouth is remarkably large; its

Under legs are much shorter than those before, to help it in climbing, being each armed with *three* very large and sharp claws, by which it holds its body on the boughs, but which, as being offensive weapons, my negroes had so cruelly chopped off; its eyes are languid, and its voice is squeaking, like that of a young cat. The greatest particularity of this creature however is, that its motion is so very slow, that it often takes two days to get up to the top of a moderate tree, from this it never descends while a leaf or a bud is remaining; beginning its devastation first at the top, to prevent its being starved in coming to the bottom, when it goes in quest of another, proceeding incredibly slow indeed while on the ground. Some say, that to avoid the pain of exercising its limbs, it forms itself into a ball, and drops down from the branches: that may be true or not, but this I now to be a fact, that it cannot mend its pace.

Of these animals there are two species in Guiana, viz. the *Ai* and the *Unan*; but in Surinam distinguished by the names of the *Ticapo* and *Dago luyaree*, or the Sheep and the Dog Sloth, on account of their hair; that of the first being bushy, and of a dirty grey, while the other is lank and reddish-coloured. This last has also but *two* claws on each foot, and the head is less round than the former. Both these creatures, by forming themselves in a clow, have often more the appearance of excrescences in the bark, than that of animals feeding upon the foliage, which frequently prevents them from being discovered by the natives and negroes, who devour their flesh with avidity."

The early Dutch settlers of Guiana were by no means unobservant, and if we had more of their letters, and if reports had been preserved, we would doubtless find many references to sloths. Jan Jacob Hartsinck published two large volumes in 1770 entitled *Beschryving van Guiana*," and on page 95 he has an illuminating paragraph on the *Ai* or *Haji*. This very page in a copy of the work which was presented to me by James Rodway, Esq., of the Georgetown Museum, shows so well the enthusiasm of arthropod bookworms, and the trials of vertebrate ones in the tropics, that I have reproduced it.

Hartsinck's paragraph translated reads, "The most curious of all the quadrupeds of this country is the *Ai* or *Haji*, thus called by the Indians on account of the noise coming from its throat, but by us going by the name of Sluggard (*Luyaard*). This name it deserves for the slothfulness of its movements, as it requires two or three

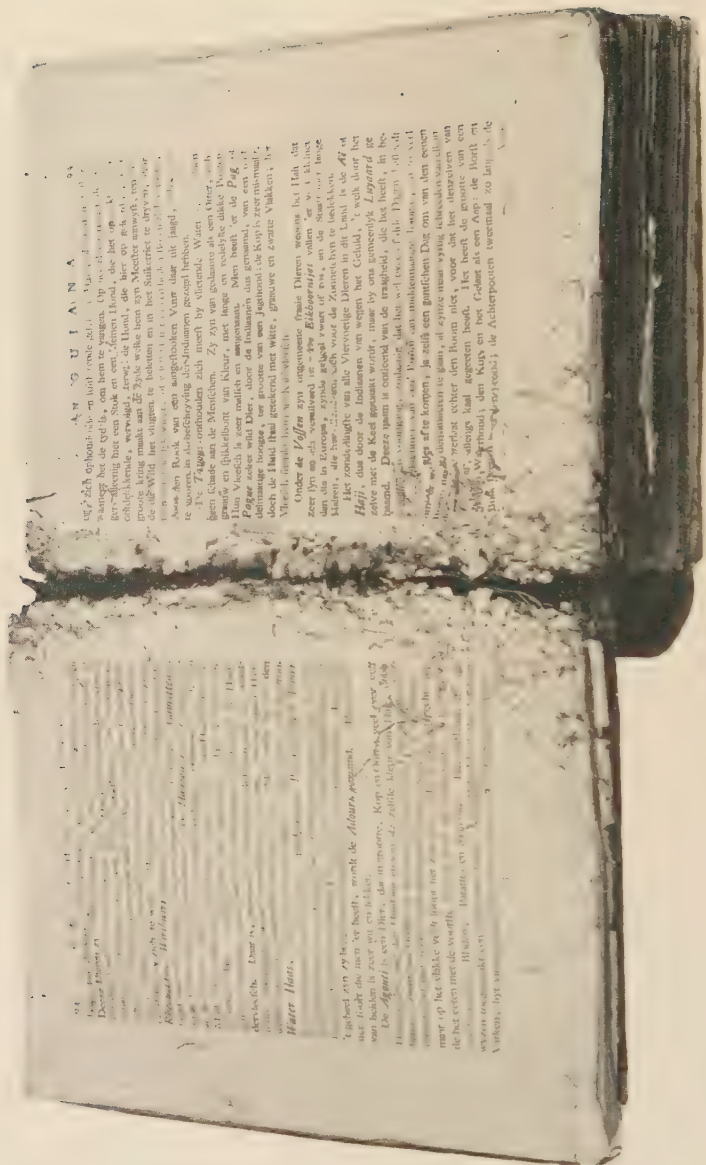


Fig. 21. An old Dutch book of the period of 1770 showing the damage done by insects of the Tropics.

ays to climb trees of a medium height, and as many again to come down. They even employ a whole day to go from one tree to another, though but fifty paces apart; it will not quit the tree until it

Pague zeker wild Dier, door de Indiaanen dus genaamd, van een middelmaatige hoogte, ter grootte van een Jagthond: de Kop is zeer mismaakt, doch de Huid fraai getekend met witte, grauwe en zwarte Vlakken; het Vleesch smaakt byna als Kalfsvleesch.

Onder de *Vossen* zyn ongemeene fraaie Dieren wegens het Hair dat zeer fyn en zilverd is. De *Eikhoornjes* vallen 'er veel kleiner dan die in Europa, zynde geheel zwart of ros, en de Staart met lange Hairen, die hen dienst doen zich voor de Zonnetichyn te bedekken.

Het zonderlingste van alle Viervoetige Dieren in dit Land is de *Aï* of *Haji*, dus door de Indiaanen van wegen het Geluid, 't welk door het zelve met de Keel gemaakt wordt, maar by ons gemeenlyk *Luyard* genaamd. Deze naam is ontleend van de traagheid, die het heeft, in beweging en voortgang, zoodanig dat het wel twee of drie Dagen besteedt

Fig. 22. A section of right hand page of Fig. 21, with an account of sloths observed by the Author in Dutch Guiana.

as eaten it bare from top to bottom. It is of the size of a small dog, with the head and face like a monkey. The chest and belly they rag along the ground; the hindmost legs are twice as long as the forelegs, which it keeps asunder like a frog. To each leg are attached three crooked nails, which are so powerful that one is obliged to use the greatest violence to make it let go whatever it has laid hold of. These at the same time serve it to climb the trees; it has moreover this peculiarity that it laughs and cries like an infant at one and the same time. It belongs to the race of Monkeys."

Edward Bancroft in his "Essay on the Natural History of Guiana," published in 1769, reaches the lowest level of secondhand acceptance of fanciful tales. He says: "The Sloth is also common in Guiana, being of the size of a Fox; its fore feet are longer than those behind, and each foot has three claws. But the peculiar characteristic of this animal is, his insuperable aversion to motion, being of all animals the most indolent and inactive: Upon level ground they are unable to move above forty or fifty paces in a day, and whenever they ascend a tree, never leave it whilst either fruit or leaf is remaining. When by beating they are forced to move, they make the most melancholy pityful noise and grimaces. But as these animals are common to all parts of America between the Tropics, and have been repeatedly described, I shall not enter into a more particular description of them."



Fig. 23. Adult male two-toed sloth. Observe equal length of limbs, more projecting muzzle and less developed tail. Photograph by Elwin R. Sanborn.

The accounts of Bancroft, Stedman and others of their ilk evidently moved Waterton to the general condemnation of the so-called naturalists of his time, and to his humorous perpetration of his famous "Nondescript."

Concerning the Three-toed Sloth he says, "Those who have written on this singular animal, have remarked that he is in a perpetual state of pain, that he is proverbially slow in his movements, that he is a prisoner in space, and that as soon as he has consumed all the leaves of the tree which he had mounted, he rolls himself up in the form of a ball, and then falls to the ground. This is not the case."

And again "The sloth is as much at a loss to proceed on his journey upon a smooth and level floor, as a man would be who had to walk a mile on stilts upon a line of featherbeds."

Nevertheless Waterton himself judged too much of his sloth's habits from its sleeping on a chair back, and is far astray in his description of the animal's sleeping posture, and of the uselessness of its tail.

NOTES ON *Choloepus didactylus* Linné TWO-TOED SLOTH.

While I shall reserve detailed treatment of this second species of sloth for a later paper, it seems worth while to present a few of the most important contrasts between it and the Three-toed *Bradypus*.

An adult female, after two months in captivity, has become very tame, making no effort to strike with its claws, but only a gentle tug to draw one's hand to its mouth. When much annoyed, it opens its mouth wide and tries feebly to bite, and could probably do damage, as its teeth are so much longer and sharper than those of *Bradypus*. Three other newly caught individuals were extremely savage and active, infinitely more dangerous than Three-toed Sloths ever are.

The two species of sloths, physically and psychologically, are much more than generically separated. They are wholly unlike in every way. In activity and general correlation the two-toed is about three times as developed as the other animal.

The eyes are larger and the optical divergence is 34° . The nose is the most prominent feature, and the nostrils large and flaring, while the whole of the surrounding skin is constantly moist. Although the movements are slow in comparison with other types of animals, they are about three times as rapid and as correlated as those of the three-toed species.

The head is constantly moved about, the attention is more concentrated, as to eye and ear at least. Over the ground this is especially noticeable and when going steadily over ground with good gripping facilities, such as short grass, the animal actually walks upright, or on all four soles, with the hind legs gathered beneath it, and the entire body clear of the ground. The head is raised high, now and then dropping the muzzle to the ground. Poor as the eyesight is, the direction is chosen after a survey of the surroundings.

The difference in direction of the hair on some portions of the body, and the total absence of a tail, indicate radical changes in arboreal mode of life.

The two toes on the fore feet and the narrow, elongated foot indicate specialization for arboreal life comparable with the anterior limbs of the spider monkeys and gibbons, but the bare sole is more generalized than the hair-covered foot of *Bradypus*.

The hair is much finer and longer than that of the three-toed, and there is less of a dense under-coat. The absence of this defense is perhaps compensated for by the increased activity and, (as observed in other individuals) a greatly enhanced ability to defend itself by strength and mobility of claws, and activity of head and neck, and length and sharpness of teeth.

In eating, this sloth shows a remarkable skill in manipulating the leaf-bearing branches. One is pulled toward its mouth and when it breaks off, the stem is held daintily in the grip of the claws against the palm, and is turned and pushed forward as the leaflets are devoured. This animal will take wild plum leaves called hog-plum or "hobo" from the hand.

In sleeping, it descends and rests its whole back on the floor of the cage and curls up into a ball.

A most interesting character is that when it decides to descend a tree-trunk or branch it turns around and comes down head first, with the body quite free of the trunk, not half clinging, half sliding tail first, as the three-toed do.

No sound but a low hiss, uttered when suddenly disturbed, has been heard.

The male lacks the bright colored dorsal spot and the general coloration is light grey. In detail the hair around the face is light ochraceous buff, shading up on the forehead through greyish olive to mummy brown at the back of the head. The back of the neck and

houlders are light grey tinged with algal green; limbs cinnamon brown; back generally tiller buff, becoming buffy on ventral surface and darker toward tail; soles dark vinaceous drab with a few large coarse, flesh-colored markings; eye tawny olive.

EARLY LITERATURE

ASHTON, JOHN.

1890. *Curious Creatures in Zoology*. (Frederick Warne & Co., Bedford Street, Strand, London.)

BANCROFT, EDWARD.

1749. An essay on the Natural History of Guiana, in South America. (T. Becket & P. A. De Hondt.)

GORDON, PAT.

1708. *Geography Anatomiz'd: or The Geographical Grammar*. (Printed for John Nicholson, John Sprint, and S. Burroughs, in Little Britain; Andr. Ball at the Cross-Keys and Bible in Cornhill, & R. Smith under the Royal Exchange.)

PURCHAS, SAMUEL.

1906. *Hakluytus Posthumus, or Purchas His Pilgrimes*. (James Mac Lehosé & Sons, Glasgow.)

TEDMAN, CAPT, J. G.

1796. *Narrative of a Five Years' Expedition against the revolted Negroes of Surinam, from 1772 to 1777*. (J. Johnson, St. Paul's Church Yard, and J. Edwards, Pall Mall.)

WATERTON, CHARLES.

1870. *Natural History Essays*. (Frederick Warne & Co., Bedford St., Strand, London.)
1852. *Wanderings in South America*. (B. Fellowes, Ludgate Street, London.)

